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Assessing the effect of a flipped classroom on students' learning performance

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ABSTRACT

This research investigates the effect of the flipped classroom on learning performance in management classes at vocational and technical colleges concentrating on cognitive style as a mediating factor. The researcher examines the difference in learning achievements, successful intelligence (analytical, creative, and practical intelligence), and learning attitudes among students who have experienced the flipped classroom method and those who receive traditional instruction through a quasi-experimental design implemented for students from 5 vocational and technical colleges. The study uses Sternberg's successful intelligence theory to determine how this pedagogical approach affects various aspects of intelligence. Key findings indicate that the flipped classroom approach is more effective than the traditional one in improving cognitive learning achievement, analytical, creative and practical intelligence, and a positive learning attitude. However, cognitive style, particularly visual versus verbal preferences showed limited impact on the effectiveness of flipped classroom learning. Therefore, flipped classrooms benefit learning performance but these benefits work irrespective of the student's cognitive style. Thus, the research is of great importance to vocational education practitioners in general and promotes the concept of flipped classrooms which might positively affect the quality of management learning.

Contribution/Originality: This study uniquely examines the impact of the flipped classroom on learning performance in management education, integrating cognitive style as a mediating factor. According to Sternberg's successful intelligence theory, the flipped classroom improves cognitive accomplishments and perspectives.

1. INTRODUCTION

Vocational education is vital for workforce needs and economic growth, varying globally to match economic and social contexts (Li & Pilz, 2023). In China, vocational education has evolved from ancient artisan traditions to modern forms influenced by Western models in the early 20th century (Ling, Chung, & Wang, 2023). However, traditional teaching methods in these institutions often struggle to meet diverse student needs and workplace demands.

The limitations of traditional lecture-based approaches are increasingly recognized as they often fail to develop the abilities needed in today's job market (Hafeez, 2021). The flipped classroom model which emphasizes active learning and practical application is a promising alternative (Hake, 2022). In this model, students engage with new material outside the classroom through digital content while classroom time is used for interactive, problem-solving activities (Jaiswal, 2021; Martins, 2020).

This research combines R.J.J. Sternberg's view of successful intelligence alongside the flipped classroom in vocational and technical colleges (VTCs). Sternberg's theory, challenging the monadic nature of intelligence by referring to different student abilities and a holistic approach has influenced American education somewhat but is rarely studied in VTC instruction especially in China (Lee, 2019). This study explores the impact of the flipped classroom on learning performance in management courses. It also analyzes the incorporation of Sternberg's theory into the flipped classroom for management courses focusing on skill enrichment, personal gifts and practice. The study discusses the impact of digital media's development in facilitating flipped classrooms which affect a variety of cognitive types and visual-verbal preferences. The objective is to present key insights for vocational education practitioners in terms of curriculum development and help the student explore his or her potentials at VTCs.

This research posits the following questions:

i. Is there an improvement in learning performance with the flipped classroom approach in VTCs' management courses?
ii. Is learning performance different between flipped and traditional classroom students?
iii. Does the flipped classroom approach make a difference in learning performances among students with varying cognitive styles?

This study seeks to provide vocational teachers with new perspectives for curriculum development and help students realize their potential and practical ambitions in a modern educational landscape by addressing these questions.

Here are the hypotheses for this research:

Hypothesis 1: There is a difference in achievement test performance before and after teaching duration between students who receive "flipped classroom" teaching and those who receive "traditional teaching."

Hypothesis 2: There is a difference in the performance of successful intelligence (analytical, creative, and practical intelligence) before and after teaching duration between students who receive "flipped classroom" teaching and those who receive "traditional teaching."

Hypothesis 3: There is a difference in learning attitudes before and after teaching duration between students who receive "flipped classroom" teaching and those who receive "traditional teaching".

Hypothesis 4: There is a difference in achievement test performance after teaching duration among students with different cognitive styles who receive "flipped classroom" teaching.

Hypothesis 5: There is a difference in the performance of successful intelligence (analytical, creative, and practical intelligence) after teaching duration among students with different cognitive styles who receive "flipped classroom".

Hypothesis 6: There is a difference in learning attitudes after teaching duration among students with different cognitive styles who receive "flipped classroom".

This research is significant in demonstrating how the flipped classroom can enhance student engagement and performance, especially in VTCs given the background of successful implementations of the flipped classroom model in different institutions such as Lake Elmo Elementary School, Algonquin College, Harvard University, and Byron High School (Guan, 2013; Logan, 2015; Walne, 2012). The integration of AI in this model further personalizes learning, optimizes classroom interactions (Lo & Hew, 2023) and reduces administrative burdens (Lv, 2023) ensuring that education methods are modernized and effective in meeting contemporary educational needs (Lawan et al., 2023).

2. LITERATURE REVIEW

2.1. Flipped Classroom

A flipped classroom involves students self-learning before class and then engaging in interactions and in-depth discussions with lecturers and fellow students during class. According to Figure 1, this approach flips the traditional teaching model's one-way learning style from lecturer to student shifting the focus to a student-centered model.

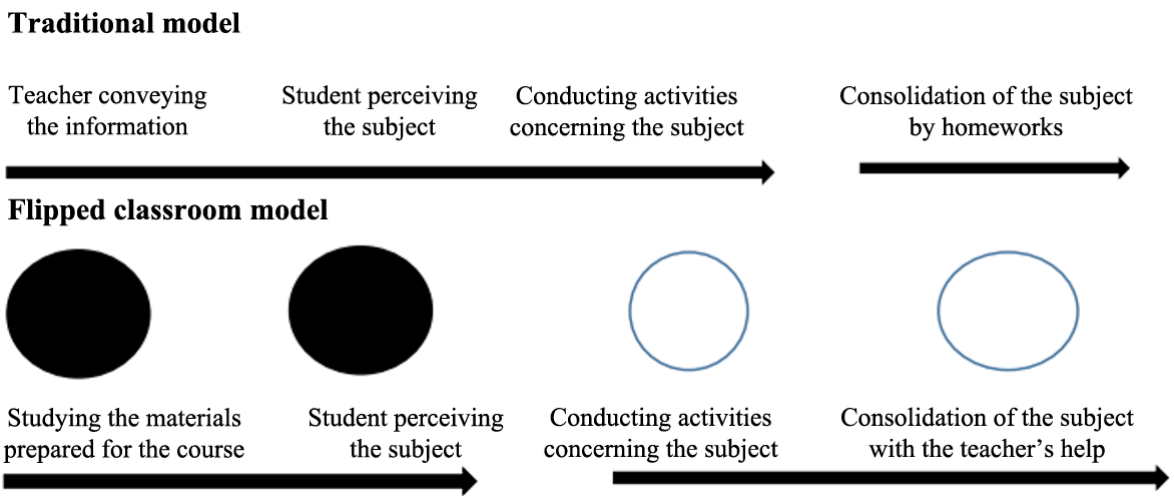

Figure 1. Flipped classroom and traditional teaching models.

Source: Say and Yildirim (2020).

It has become one of the current trends in educational innovation (Galindo-Dominguez, 2021). Eric Mazur's computer-assisted teaching methods which increased student involvement are prime examples of the flipped classroom idea which has evolved significantly since the 1990s and represents a paradigm change in education from teacher-centered delivery to supported learning (Gopalan, Daughrity, & Hackmann, 2022). The development of the flip model in this case was also pushed forward by formal recognition that gained Baker's "classroom flip" presentation in 2000 as well as University of Wisconsin-Madison experiments with eTeach software for video creation. The flipped classroom was popularized with Salman Khan's Khan Academy, an online resource of tutorials that supported flexible learning and which are held in high esteem at the TED (Technology, Entertainment, Design) conference for its potential to democratize education. This development demonstrates how the flipped classroom may change learning practices using digital technology and collaborative learning strategies, indicating its success in all educational domains and topics. The model's practical applications in schools such as Byron High School's use of self-made teaching materials and the increase in student and parent satisfaction at Lake Elmo Elementary School (Walne, 2012) as well as its adoption by higher education institutions including Harvard University and Algonquin College, for a variety of courses can attest to its effectiveness and adaptability (Walne, 2012). The model's practical applications in schools such as Byron High School's use of self-made teaching materials and the increase in student and parent satisfaction at Lake Elmo Elementary as well as its adoption by higher education institutions, including Harvard University and Algonquin College can attest to its effectiveness and adaptability.

Artificial Intelligence (AI) has a transformative nature in education particularly in improving flipped classroom production by allowing individualized learning as well as increasing daily efficiency (Huang, Lu, & Yang, 2023). Flipped classrooms in the AI context can make automated creation and distribution of tailor-made content, which is based on the specific learning styles and needs of students. This individualized approach is extremely important as it enables students to comprehend the material before the class meetings and as a result, the classroom sessions can be more interactive and learner-centered (Bye, 2018). AI-driven data analytics further offer teachers in-depth insights into student engagement and comprehension that ultimately help to apply precise interventions and aids. Moreover, it can create a highly active learning situation by creating a platform for real-time questions and feedback before the real classes. The overall experience leads to informed and more involved students during class activities. AI can be used as a tool for the flipped classroom, allowing teachers to automate routine tasks and make learning more informative and engaging for students (Sanchez-Gonzalez & Terrell, 2023).

The flipped classroom is an approach towards expanding student participation and active learning with technological absorption in addition to instructional reorganization, extending beyond the combination of legacy technology with contemporary pedagogy (Akçayır & Akçayır, 2018). This approach paves the way for students to

interact with prerecorded video materials before attending class so that they can have discussions and exercises during the class, maximizing face-to-face interactions and changing the teacher from a lecturer to coach (Galindo-Dominguez, 2021). This approach based on Bloom's cognitive domain promotes the movement from lower-order skills to higher ones using technology in the promotion of flexible learning and adaptive course proceeding (Paralikar, Shah, Joshi, & Kathrotia, 2022). It includes preparation stages during which lecturers develop or gather materials for independent student learning and classroom-based collaborative activities promoting an interactive learning model. Real-time implementation has resulted in monumental academic gains and better engagement, spanning job satisfaction among lecturers for the students to gain critical thinking and teamwork skills. The flipped classroom through which flip learning and teaching is implemented has revolutionized the education process by addressing 21st-century educational needs of sustaining diverse learning patterns supporting self-direct in exploration, and making room for participatory discourses.

2.2. Successful Intelligence

In his seminal work, Sternberg (2003) introduced the theory of successful intelligence delineating it into three distinct facets: analytical, creative and practical intelligence. These dimensions play a role in the individuals seeking to achieve their desired goals within the socio-cultural environment. Sternberg (2003) stated that analytical intelligence involves problem-solving and the ability to critically reflect on one's mental processes. At the same time, creative intelligence encompasses the formulation of new questions and creative ideation. However, practical intelligence carries out ideas and results in analytical findings. According to Ayoub and Aljughaiman (2016) tripartite cognitive capacities benefit academic performance as well as effective solutions to everyday life issues. The principles of successful intelligence create a commitment not only to develop in the children analytical, creative, and practical intelligence but also to help them define specific objectives for success through their incorporation into pedagogical praxis. In this study, the foundational framework derives from the pedagogical and evaluative constructs of analytical, creative, and practical intelligence by Sternberg, Grigorenko, Ferrari, and Clinkenbeard. The research's primary evaluative instrument is the "Sternberg Triarchic Abilities Test" (STAT) (Sternberg, 1993). This diagnostic tool is calibrated to gauge student competencies within the three delineated dimensions of successful intelligence. The evaluative domains encompass: firstly, the analytical dimension which is oriented toward competencies such as comparative reasoning, analytical assessment, evaluative judgment, and interpretative acumen. Secondly, the creative dimension accentuates cognitive capacities such as imaginative prowess, design intuition, predictive reasoning, and innovative ideation. Lastly, the practical dimension focuses on the appraisal of problem-solving proficiency rooted in experiential contexts.

2.3. Evaluation of Learning Performance

Learning performance is mainly assessed in terms of the acquired knowledge, abilities, and sentiments of students. These results show the transformation in students following their participation in a learning session. Such evaluations help understand a student's grasp and response to the imparted content. Wang and Zhang (2020) posit that these outcomes lead to positive shifts in thought processes, feelings, and skill sets being lasting products of learning engagements. On the same line, Munna and Kalam (2021) assert that these outcomes not only signify the milestones achieved by learners throughout their educational journey but are also important in determining the efficacy of teaching.

In this research, teachers assess the students based on their understanding, applied skills, and disposition toward the subject upon the completion of teaching sessions. A superior score in this assessment mirrors a profound understanding whereas a subdued score reflects less favourable results. The primary objective behind this evaluation is to enable teachers to discern the extent of knowledge assimilation, skill development and the passion of students in aligning with the envisaged educational objectives for the course. The performance metrics employed in this

research encompass achievement tests, facets of analytical, creative, and practical intelligence and students' attitudes toward learning.

In this research, an achievement test is employed to assess the student's understanding and grasp of the curriculum once the teaching sessions conclude in the form of a written examination. Scoring higher in this test implies a commendable grasp of the subject whereas a lower score reflects a less satisfactory comprehension. The test paper for this evaluation was designed by the researcher specifically for this investigation. This test is given both before and after the teaching experiment to discern the variations in the cognitive learning of students.

In Sternberg and Collaborators's (2006) seminal work, the "Sternberg Triarchic Abilities Test" was introduced, operationalizing successful intelligence into a quantifiable assessment, capturing its three critical dimensions. The test emphasises the assessment of students' innate learning potential, based on the basic concepts of the effective intelligence theory.

Gagne, Wager, Golas, Keller, and Russell (2005) define attitude as a multi-level psychological construct that affects the human evaluation of people, an entity or even events. Olson and Zanna (1993) similarly articulate attitude as a persistent cognitive and evaluative orientation towards entities, events or individuals. Extending this understanding, learning attitude emerges as a stable, habitual predisposition, cultivated through pedagogical experiences, embodying cognitive, affective and skill-based components (Guo & Wang, 2020). In this study, learning attitude is operationalized as a student's sustained behavioral proclivity towards a subject, engendered through teaching processes (Kpolovie, Joe, & Okoto, 2014). Methodologically, this study adopts Koballa Jr's (1988) learning attitude scale to gauge variations in students' learning attitudes pre- and post-instruction, positioning it as a metric to discern student receptiveness to the flipped classroom pedagogy.

Guilford (1967) delineated cognitive styles as distinct personality dimensions influencing environmental responses, behavioral dispositions and adaptive mechanisms. Subsequent studies have characterized them as consistent patterns that govern how an individual engages in information assimilation within organizational contexts (Tennant, 2019). These patterns are also understood to underscore individuals' consistent approaches to problem-solving, thinking, perception and memory retention (Sternberg, 1997). Information processing facilitates the development of particular cognitive predispositions resulting from accumulated learning experiences central to the learning process. According to the empirical facts, learners tend to have improved processing of information in case they deal with learning materials that correspond to their cognitive styles (Aggarwal & Woolley, 2019). Some instances of these include the observation that some students prefer visual materials such as images, multimedia components, and animations whereas others may prefer text or audio (Margunayasa, Dantes, Marhaeni, & Suastra, 2019). The compound orientation on cognitive styles in this particular investigation of the current is measured using a metric done by Childers, Houston, and Heckler (1985) that also applies the SOP scale called Style of Process.

3. METHODOLOGY

3.1. Research Design

This study first establishes a research framework using both flipped classroom and traditional teaching methods in teaching experiments with the data from the results of these experiments as the basis for analysis.

This study adopts a quasi-experimental method to experiment, considering factors like research time, school administration, and class arrangements focusing on students at five VTCs. The participants are students from fifty first-year management classes at five vocational and technical colleges in Zhejiang Province to participate. The classes were randomly formed at the time of admission with a total of fifty classes assigned equally to the experimental and the control groups. Both groups participated in a twelve-week teaching experiment in the

"Fundamentals of Management" course, a specialized subject in management.

The experimental group employs a flipped classroom teaching model. Students are instructed to preview these materials before class. During class, students take part in activities like presentations, questions, and discussions. On

the other hand, the control group received traditional teaching during class by the lecturer. Both groups were assessed on learning performance before and after the teaching to facilitate comparison. The teaching experiment research design is shown in Table 1.

Table 1. Quasi-experimental research design.

Groups	Pre-test	Experimental treatment	Post-test
Experimental group	01	X1	02
Control group	03	X2	04

X1: Experimental treatment involving flipped classroom teaching.

X2: Experimental treatment involving traditional teaching.

O1, O3: Pre-test, including achievement test, analytical, creative, and practical intelligence, learning attitude.

O2, O4: Post-test, including achievement test, analytical, creative, and practical intelligence, learning attitude.

3.2. Research Population

This study involved first-year management students from five VTCs in Anhui Province, i.e., Wuhu Institute of Technology (College T), Anhui Medical College (College M), Anhui Water Conservancy Technical College (College W), Anhui Business College of Vocational Technology (College B), and Anhui Technical College of Mechanical and Electrical Engineering (College E). Each college contributed ten classes divided equally between the experimental and the control groups. In total, fifty classes participated amounting to 1,000 students. Class assignments were randomly made based on students' entrance examination numbers to ensure fairness, and students were not informed they were part of a teaching experiment to prevent bias effects. Table 2 presents the participants distribution:

Table 2. Participants' distribution by gender.

S/N	College	Gender	Experimental group	Control group	Total students
1	College T	Male	55	58	113
		Female	45	42	87
2	College M	Male	53	56	109
		Female	47	44	91
3	College W	Male	52	55	107
		Female	48	45	93
4	College B	Male	54	56	110
		Female	46	44	90
5	College E	Male	50	56	106
		Female	50	44	94
6	Total	Male	264	281	545
		Female	236	219	455
		Total	500	500	1000

3.3. Instruments

In this study, the tools used aligned with the research objectives and questions, include the learning achievement test paper, the successful intelligence scale (Sternberg Triarchic Abilities Test Level H, abbreviated as STAT Level H), the learning attitude scale, the cognitive style SOP (Style of Processing) scale, and various tools for data analysis.

3.3.1. Learning Achievement Test Paper

In the context of this study, learning achievement is reflected through the students' scores on the test papers in the subject of management. These scores are used to understand the students' cognitive performance. Higher scores indicate better learning achievement while lower scores indicate poor achievement. The test papers will be used for pre-and post-tests during the study.

3.3.2. Successful Intelligence Scale

The STAT Level H scale adopted in this study is a Chinese version of STAT based on the "Triarchic Intelligence Measure" developed by Sternberg, Ferrari, Clinkenbeard, and Grigorenko (1996). This scale aims to assess intelligence in the following three dimensions: analytical, creative, and practical. Each dimension comprises three parts: verbal, quantitative, and figural making a total of nine major questions. Each major question consists of four multiple-choice questions, totalling 36 questions. Each question is scored one point with a subtotal of 12 points for each dimension and 36 points in total. The first to third major questions in the scale belong to the analytical dimension focusing on skills such as comparison, contrast, analysis, evaluation, criticism, questioning, explanation, and interpretation. The fourth to sixth major questions in the scale fall under the practical dimension, emphasizing the assessment of problem-solving abilities based on life experiences. The seventh to ninth major questions in the scale are under the creative dimension, mainly measuring the abilities of imagination, design, invention, innovation, and prediction. In a nutshell, it can be understood that the analytical dimension of the successful intelligence scale emphasizes the ability to analyse problems, the creative dimension values innovative thinking in problem-solving and the practical dimension applies common knowledge in life to the process of problem-solving.

3.3.3. Learning Attitude Scale

"Learning attitude" in this study is evaluated by the extent of a persistent and consistent behavioral tendency that students develop during learning Management course. The learning attitude scale by Koballa Jr (1988) is used as the measurement tool in this research encompassing the following three constructs: cognitive, affective, and behavioral intentions. Firstly, the cognitive construct refers to an individual's views, beliefs, and knowledge about learning attitudes during the learning process. There's no definite right or wrong here; it reflects the individual's state regarding learning attitudes. The affective construct involves emotional reactions to learning, showing likes or dislikes ranging from very strong to very weak. The behavioral intentions construct primarily describes observable behaviour tendencies related to learning attitudes. The scale consists of multiple-choice questions, with 8 questions in the cognitive construct, 10 in the affective construct, and 9 in the behavioral intentions construct, totalling 27 questions.

3.3.4. Cognitive Style SOP (Style of Processing) Scale

In this research, the modified version of the cognitive style SOP scale developed by Childers et al. (1985) is used to measure students' cognitive style patterns. The cognitive style SOP scale categorizes test-takers into two types: (1) Verbal style: indicating learners who show a more significant preference for processing verbal and textual information. (2) Visual style: indicating learners who have a more marked preference for processing visual information, such as graphics, charts, animations, etc. The scale consists of 20 questions with 10 questions each. It adopts a five-point scale with the range from strongly disagrees to strongly agree to measure cognitive styles.

3.3.5. Data Analysis

Various statistical tests are used to analyse the data. The data will be collected from pre- and post-intervention assessments including academic achievement tests, intelligence tests, and attitude surveys. Initially, descriptive statistics will be collected, so that the demographic characteristics of the sample can be shown. To determine the differences in learning performance before and after the traditional classroom model, paired t-tests will be conducted for each dependent variable: academic achievement, successful intelligence, and learning attitude. If the data fails to meet the assumptions of normality required for parametric tests, the non-parametric Wilcoxon Signed Rank Test will be used as an alternative. Similar analysis will be conducted to analyze the differences in learning performance before and after the flipped classroom model for the same dependent variables.

Hierarchical regression analysis will be conducted to evaluate cognitive style's moderation on the relationship between demographic profiles (college, gender) and learning performance. In this analysis, learning performance outcomes will be regressed on demographic variables and cognitive style will be added as an interaction term to investigate its moderating effect. This approach will help in identifying whether the impact of demographic factors on learning performance differs based on students' cognitive styles under both traditional and flipped classroom settings. All statistical analyses are performed using appropriate software like SPSS (Statistical Package for the Social Sciences) or R (R Programming Language, commonly referred to simply as "R"). Results will be considered significant at an alpha level of 0.05. The findings from these analyses will reveal the effect of the traditional versus flipped classroom method and cognitive style's role in shaping learning outcomes.

3.4. Validity and Reliability Tests

The learning achievement test papers were developed by the researcher before the experimental study on the basis of the curriculum and the teaching objectives. They were then reviewed and modified with the assistance of three lecturers experienced in teaching management courses within the school.

Cronbach's alpha measures reliability with the coefficient being directly proportional to it. In basic research, an acceptable reliability threshold is 0.8 or above while in exploratory research, it is 0.70. Therefore, Cronbach's alpha serves as a crucial indicator for assessing the reliability of questionnaires (Taber, 2018). Figure 2 and Table 3 are common interpretations of Cronbach's alpha results:

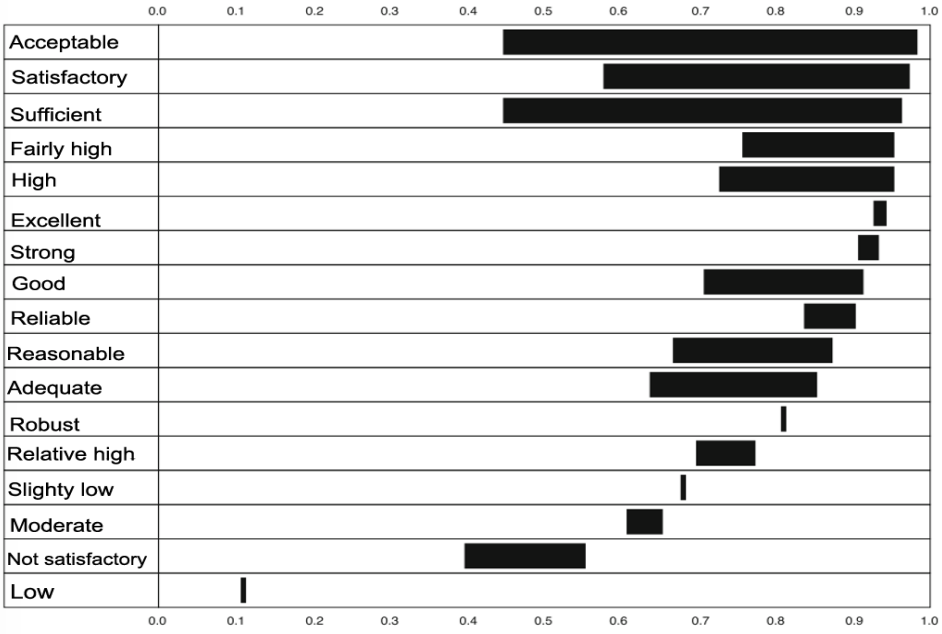

Figure 2. Qualitative descriptors for values, ranges of values of Cronbach's alpha.
Source: Taber (2018).

Table 3. Interpretation of Cronbach's alpha results

S/N	Questionnaires		Cronbach's alpha	Cronbach's alpha range	Questionnaire reliability
1	Academic achievement		0.90	>0.8	Good
2	Successful intelligence	Analytical	0.81	>0.8	Good
		Creative	0.81	>0.8	Good
		Practical	0.80	0.7-0.8	Acceptable
3	Learning attitude		0.95	>0.8	Good
4	Cognitive style		0.88	>0.8	Good

4. FINDING AND DISCUSSION

4.1. The Impact of Traditional and Flipped Classrooms on Students' Learning Performance in Specialized Courses

This section explores the impact of the flipped classroom on learning performance in management courses at vocational and technical colleges. Paired t-tests and two independent sample t-tests are conducted to adjust for pre-treatment differences between the two groups using SPSS 26.0 for Windows to control for external variables.

4.1.1. Significant Impact of Flipped Classroom on Learning Achievement

4.1.1.1. Academic Achievement Test Scores for Control Group

This paired t-test assesses the differences in academic achievement test scores before and after implementing the traditional classroom model. This method was selected to compare the mean scores of the same group of students prior to and following the intervention.

The results indicate a significant increase in the academic achievement test scores following the traditional classroom model. The mean pre-test score of 30.68 and the mean post-test score of 61.67 result in a mean difference of -31.00. The t-value is -116.33 and the p-value is less than 0.05 suggesting this increase is statistically significant. The statistical analyses provide robust evidence that the traditional classroom model positively impacts academic achievement test scores.

4.1.1.2. Academic Achievement Test Scores for Experimental Group

The paired t-test compared the mean scores of the same group of students before and after the intervention.

The results indicate a significant increase in the academic achievement test scores following the flipped classroom model. The mean pre-test score of 30.82 and the mean post-test score of 72.47 result in a mean difference of -41.64. The t-value is -161.87 and p-value is less than 0.05 suggesting this increase is statistically significant. The statistical analyses provide robust evidence that the flipped classroom model positively impacts academic achievement test scores.

4.1.1.3. Comparative Analysis of Traditional and Flipped Classroom Models' Effect on Academic Achievement Test Scores

A two-independent sample t-test was conducted to determine the effectiveness of different teaching models on academic achievement test scores. This involved comparing the mean differences in academic achievement test scores before and after the interventions for both instructional methods.

Table 4. Paired t-test results.

Paired samples statistics									
Mean			**N**	**Std. deviation**			**Std. error mean**		
Pair 1 pre-academic test		30.68	500	4.080			0.182		
Post-academic test		61.67	500	5.352			0.239		
Paired samples test									
Pair name	Test type			Paired differences					
				Std. error mean	95% confidence interval of the difference		t	df	Sig. (2-tailed)
		Mean	Std. deviation		Lower	Upper			
Pair 1	Pre-academic test-post academic test	-30.998	5.958	0.266	-31.522	-30.474	-116.332	499	0.000

Table 5. Paired t-test results.

Paired samples statistics									
Mean			**N**	**Std. deviation**			**Std. error mean**		
Pair 1 pre-academic test		30.82	500	4.083			0.183		
Post-academic test		72.47	500	5.507			0.246		
Paired samples test									
Pair name	Test type		Std. deviation	Paired differences					
				Std. error mean	95% confidence interval of the difference		t	df	Sig. (2-tailed)
		Mean			Lower	Upper			
Pair 1	Pre-academic test-post academic test	-41.642	5.753	0.257	-42.147	-41.137	-161.866	499	0.000

Table 6. Two independent sample T-test results.

Group statistics										
Test type	**Class**		**N**	**Mean**	**Std. deviation**	**Std. error mean**				
Pre-test	Control group		500	30.68	4.080	0.182				
	Experimental group		500	30.82	4.083	0.183				
Post-test	Control group		500	61.67	5.352	0.239				
	Experimental group		500	72.47	5.507	0.246				
Independent samples test										
Type of variance assumption		F	Sig.	t	Df	Sig. (2-tailed)	Mean difference	Std.error difference	95%confidence interval of the difference	
									Lower	Upper
Pre-test	Equal variances are assumed.	0.023	0.879	-0.573	998	0.567	-0.148	0.258	-0.655	0.359
	Equal variances are not assumed.			-0.573	997.999	0.567	-0.148	0.258	-0.655	0.359
Post-test	Equal variances are assumed.	0.001	0.978	-31.422	998	0.000	-10.792	0.343	-11.466	-10.118
	Equal variances are not assumed.			-31.422	997.190	0.000	-10.792	0.343	-11.466	-10.118

Tables 4 and 5 show that in the pre-test, the t-value was -0.57 and the p-value was greater than 0.05, indicating that the difference in mean score improvements between the traditional and experimental groups was not statistically significant. In contrast, the post-test results showed a t-value of -31.42 and a p-value of less than 0.05, suggesting that the difference in mean score improvements was statistically significant. According to Table 6, the analysis of the two independent sample t-tests revealed that the flipped classroom model significantly enhanced academic achievement test scores. The experimental group had a mean post-test score of 72.47 compared to 61.67 for the control group resulting in a mean difference of 10.79. This significant difference highlights the substantial impact of the flipped classroom model on students' academic achievement.

4.1.2. Significant Impact of Flipped Classroom on Successful Intelligence Performance

4.1.2.1. Successful Intelligence Performance for Control Group

This paired t-test compared the mean scores of the same group of students before and after the intervention.

Table 7. Paired t-test results

Paired samples statistics									
Mean			**N**	**Std. deviation**	**Std. error mean**				
Pair 1 pre-intelligence		19.88	500	2.029	0.091				
Post intelligence		19.81	500	1.968	0.088				
Paired samples test									
Pair name	Test type	Paired differences					T	df	Sig.(2-tailed)
		Mean	Std. deviation	Std. error mean	95% confidence interval of the difference				
					Lower	Upper			
Pair 1	Pre-intelligence-post intelligence	0.072	2.517	.113	-0.149	0.293	0.640	499	0.523

The statistical analyses of Table 7 provide consistent evidence that the traditional classroom model does not significantly impact successful intelligence scores.

4.1.2.2. Successful Intelligence Performance for Experimental Group

This paired t-test compared the mean scores of the same group of students before and after the intervention. In cases where the data did not meet the normality assumptions required for parametric tests, the non-parametric Wilcoxon Signed Rank test was used as an alternative.

Table 8. Paired t-test results.

Paired samples statistics									
Mean			**N**	**Std. deviation**	**Std. error mean**				
Pair 1 pre-intelligence		19.84	500	2.000	0.089				
Post intelligence		28.98	500	2.215	0.099				
Paired samples test									
Pair name	Test type	Mean	Std. deviation	Paired differences			t	df	Sig. (2-tailed)
				Std. error mean	95% confidence interval of the difference				
					Lower	Upper			
Pair 1	Pre-intelligence - post intelligence	-9.146	2.377	0.106	-9.355	-8.937	86.054	499	0.000

Table 9. Two independent sample t-test results.

Group statistics									
Test type	**Class**	**N**	**Mean**	**Std. deviation**	**Std. error mean**				
Pre intelligence	Control group	500	19.88	2.029	0.091				
	Experimental group	500	19.84	2.000	0.089				
Post intelligence	Control group	500	19.81	1.968	0.088				
	Experimental group	500	28.98	2.215	0.099				
Independent samples test									
Type of variance assumption	F	Sig.	T	df	Sig. (2-tailed)	Mean difference	Std. error difference	95%confidence interval of the difference	
								Lower	Upper
Pre intelligence equal variances are assumed.	0.003	0.957	0.345	998	0.730	0.044	0.127	-0.206	0.294
Equal variances are not assumed.			0.345	997.794	0.730	0.044	0.127	-0.206	0.294
Post intelligence equal variances are assumed.	11.352	0.001	-69.233	998	0.000	-9.174	0.133	-9.434	-8.914
Equal variances are not assumed.			-69.233	984.400	0.000	-9.174	0.133	-9.434	-8.914

The analyses of Tables 8 and 9 indicate a significant increase in the successful intelligence scores following the flipped classroom model.

4.1.2.3. Comparative Analysis of Traditional and Flipped Classroom Model's Effect on Successful Intelligence Scores

These two independent samples t-test analysis compares the mean differences in successful intelligence scores before and after the interventions for both instructional methods.

The difference in the mean score improvements between the traditional and the experimental groups is statistically significant. The two independent sample t-test analyses reveal that the flipped classroom model is significantly more effective in improving successful intelligence scores.

4.1.3. Significant Impact of Flipped Classroom on Learning Attitude

4.1.3.1. Learning Attitude Scores for Control Group

This paired t-test compared the mean scores of the same group of students before and after the intervention. In cases where the data did not meet the normality assumptions required for parametric tests, the non-parametric Wilcoxon Signed Rank test was used as an alternative.

Table 10. Paired t-test results.

Paired samples statistics				
Mean		**N**	**Std. deviation**	**Std. error mean**
Pair 1 pre attitude	69.03	500	6.415	287
Post attitude	68.64	500	6.491	0.290

Paired samples test									
Pair name	Test type	Paired differences					t	df	Sig. (2-tailed)
		Mean	Std. deviation	Std. error mean	95% confidence interval of the difference				
					Lowe	Upper			
Pair 1	Pre-attitude-post attitude	0.394	8.032	0.359	-.312	1.100	1.097	499	0.273

According to Table 10, the increase in learning attitude scores is not significant following the traditional classroom model. The statistical analyses provide consistent evidence that the traditional classroom model does not significantly impact learning attitude scores.

4.1.3.2. Learning Attitude Scores for Experimental Group

This paired t-test compared the mean scores of the same group of students before and after the intervention. In cases where the data did not meet the normality assumptions required for parametric tests, the non-parametric Wilcoxon Signed Rank test was used as an alternative.

Table 11. Paired t-test results.

Paired samples statistics					
Mean			**N**	**Std. deviation**	**Std. error mean**
Pair 1	Pre attitude	68.95	500	6.490	0.290
	Post attitude	102.04	500	6.855	0.307

Paired samples test									
Pair name	Test type	Mean	Std. deviation	Paired differences				df	Sig. (2-tailed)
				Std. error mean	95%confidence interval of the difference				
					Lower	Upper	T		
Pair 1	Pre-attitude-post attitude	-33.092	8.902	0.398	-33.874	-32.310	-83.123	499	0.000

Table 12. Two independent sample t-test results.

Group statistics					
Test type	**Class**	**N**	**Mean**	**Std. deviation**	**Std. error mean**
Pre attitude	Control group	500	69.03	6.415	287
	Experimental group	500	68.95	6.490	0.290
Post attitude	Control group	500	68.64	6.491	290
	Experimental group	500	102.04	6.855	0.307

Independent samples test										
Test type	Type of variance assumption	F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std.error difference	95%confidence interval of the difference	
									Lower	Upper
Pre attitude	Equal variances are assumed.	0.21	0.885	0.211	998	0.833	0.086	0.408	0.715	0.887
	Equal variances are not assumed.	—	—	0.211	997.866	0.833	0.086	0.408	0.715	0.887
Post attitude	Equal variances are assumed.	0.883	0.348	-79.113	998	0.000	-33.400	0.422	-34.228	-32.572
	Equal variances are not assumed.	—	—	-79.113	995.037	0.000	-33.400	0.422	-34.228	-32.572

The analyses of Tables 11 and 12 indicate a significant change in the learning attitude scores following the flipped classroom model.

4.1.3.3. Comparative Analysis of Traditional and Flipped Classroom Model's Effect on Learning Attitude Scores

These two independent samples t-test analysis compares the mean differences in learning attitude scores before and after the interventions for both instructional methods.

The two independent sample t-test analyses reveal that the flipped classroom model is significantly more effective in improving learning attitude scores.

4.2. Moderating Role of Cognitive Style

4.2.1. Traditional Classroom Model

A hierarchical regression analysis was conducted to investigate whether cognitive style moderates the relationship between the selected demographic profiles (college, gender) and learning performance in the traditional classroom model. This analysis was to determine if the inclusion of cognitive style as an interaction term with the demographic variables would significantly predict learning performance which includes academic achievement test scores, successful intelligence scores, and learning attitude scores.

The hierarchical regression models were specified as follows:

$$Model\ 1: Learning\ Performance = \beta 0 + \beta 1(College) + \beta 2(Gender) + \varepsilon$$

$$Model\ 2: Learning\ Performance = \beta 0 + \beta 1(College) + \beta 2(Gender) + \beta 3(Cognitive\ Style) + \varepsilon$$

$$Model\ 3: Learning\ Performance = \beta 0 + \beta 1(College) + \beta 2(Gender) + \beta 3(Cognitive\ Style) + \beta 4(CollegeCognitive\ Style) + \beta 5(GenderCognitive\ Style) + \varepsilon$$

Table 13. ANOVA paradigm of academic achievement test scores.

ANOVA[a]					
Sum of model squares		**df**	**Mean square**	**F**	**Sig.**
1(b) Regression	3267.432	5	653.486	29.272	0.000
Residual	11028.430	494	22.325	—	—
Total	14295.862	499	—	—	—
2(c) Regression	3269.704	6	544.951	24.366	0.000
Residual	11026.158	493	22.365	—	—
Total	14295.862	499	—	—	—
3(d) Regression	3270.097	7	467.157	20.846	0.000
Residual	11025.765	492	22.410	—	—
Total	14295.862	499	—	—	—

Note: a. Dependent variable: Post academic test.
b. Predictors: (Constant), college E, gender, college M, college B and college W.
c. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
d. Predictors:(Constant), college E, gender, college M, college B, college W cognitive and gender*cognitive.

Table 14. Hierarchical regression results of academic achievement test scores.

Model summary									
Model	**R**	**R square**	**Adjusted R square**	**Std. error of the estimate**	**R square change**	**F change**	**df1**	**df2**	**Sig. F change**
a	0.478	0.229	0.221	4.725	0.229	29.272	5	494	0.000
b	0.478	0.229	0.219	4.729	0.000	0.102	1	493	0.750
c	0.478	0.229	0.218	4.734	0.000	0.018	1	492	0.895

Note: a. Predictors: (Constant), college E, gender, college M, college B, and college W.
b. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
c. Predictors: (Constant) ,college E, gender, college M, college B, college W and cognitive, gender*cognitive.

Table 15. Coefficients of academic achievement test scores.

Coefficients[a]					
Unstandardized		**Coefficients std. error**	**Standardized coefficients**	**t**	**Sig.**
Model	**B**		**Beta**		
(Constant)	59.883	0.527	—	113.676	0.000
Gender	1.521	0.424	0.142	3.591	0.000
College M	2.910	0.668	0.218	4.355	0.000
College W	-1.094	0.668	-0.082	-1.637	0.102
College B	4.705	0.668	0.352	7.041	0.000
College E	-1.584	0.669	-0.118	-2.369	0.018
(Constant)	59.971	0.595	—	100.806	0.000
Gender	1.524	0.424	0.142	3.594	0.000
College M	2.910	0.669	0.218	4.351	0.000
College W	-1.108	0.670	-0.083	-1.653	0.099
College B	4.711	0.669	0.352	7.041	0.000
College E	-1.588	0.669	-0.119	-2.373	0.018
Cognitive	0.140	438	-0.013	-0.319	0.750
(Constant)	60.008	657	—	91.296	0.000
Gender	1.452	0.690	0.136	2.104	0.036
College M	2.911	670	218	4.348	0.000
College W	-1.111	0.671	-0.083	-1.655	0.099
College B	4.714	0.670	0.353	7.035	0.000
College E	-1.588	0.670	-0.119	-2.370	0.018
Cognitive	-0.201	0.636	-0.018	-0.316	0.752
Gender*cognitive	0.116	0.876	0.010	0.132	0.895

Note: a. Dependent variable: Post academic test.

Hierarchical regression analysis tests the significant mediation of cognitive style between demographic characteristics (gender and school) and academic achievement test scores. This study used a two-step hierarchical approach, introducing predictor factors in the following order: demographic characteristics (gender and school), cognitive style, and the interaction term between cognitive style and gender. The ANOVA (Analysis of Variance) table shows that all three models are statistically significant.

The analyses of Tables 13, 14 and 15 indicate that after considering gender and school, cognitive style and the interaction term between cognitive style and gender are not significantly related to students' academic achievement test scores.

Table 16. ANOVA paradigm of successful intelligence scores.

ANOVA[a]					
Sum of model squares		**Df**	**Mean square**	**F**	**Sig.**
1(b) Regression	550.160	5	110.032	39.309	0.000
Residual	1382.790	494	2.799	—	—
Total	1932.950	499	—	—	—
2(c) Regression	554.179	6	92.363	33.026	0.000
Residual	1378.771	493	2.797	—	—
Total	1932.950	499	—	—	—
3(d) Regression	554.511	7	79.216	28.274	0.000
Residual	1378.439	492	2.802	—	—
Total	1932.950	499	—	—	—

Note: a. Dependent variable: Post intelligence.
b. Predictors: (Constant), college E, gender, college M, college B and college W.
c. Predictors: (Constant), college E, gender, college M, college B, college and and W, cognitive.
d. Predictors: (Constant), college E, gender, college M, college B, college and W cognitive and gender*cognitive.

Table 17. Hierarchical regression results of successful intelligence scores.

Model summary									
Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics				
					R square change	F change	df1	df2	Sig. F change
a	0.533	0.285	0.277	1.673	0.285	39.309	5	494	0.000
b	0.535	0.287	0.278	1.672	0.002	1.437	1	493	0.231
c	0.536	0.287	0.277	1.674	0.000	0.118	1	492	0.731

Note: a. Predictors: (Constant), college E, gender, college M, college B and college W.
b. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
c. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive, gender*cognitive.

Table 18. Coefficients of successful intelligence scores.

Coefficients[a]					
Unstandardized		d coefficients	Standardized coefficients	t	Sig.
Model	B	Std. error	Beta		
1 (Constant)	19.130	0.187	—	102.553	0.000
Gender	0.892	0.150	0.226	5.946	0.000
College M	-0.822	0.237	-0.167	-3.475	0.001
College W	-0.753	0.237	-0.153	-3.183	0.002
College B	1.489	0.237	0.303	6.293	0.000
College E	1.135	0.237	0.231	4.793	0.000
2 (Constant)	19.013	0.210	—	90.377	0.000
Gender	0.888	0.150	0.225	5.921	0.000
College M	-0.822	0.237	-0.167	-3.476	0.001
College W	-0.735	0.237	-0.149	-3.100	0.002
College B	1.481	0.237	0.301	6.262	0.000
College E	1.140	0.237	0.232	4.817	0.000
Cognitive	0.186	0.155	0.046	1.199	0.231
3 (Constant)	19.047	0.232	—	81.954	0.000
Gender	0.822	0.244	0.209	3.368	0.001
College M	-0.821	0.237	-0.167	-3.470	0.001
College W	-0.737	0.237	-0.150	-3.105	0.002
College B	1.484	0.237	0.302	6.264	0.000
College E	1.140	0.237	0.232	4.814	0.000
Cognitive	0.130	0.225	0.032	578	0.564
Gender*cognitive	0.107	0.310	0.026	344	0.731

Note: a. Dependent variable: Post intelligence.

The analyses of Table 16, 17 and 18 indicate that after considering gender and school, cognitive style and the interaction term between cognitive style and gender are not significantly related to students' successful intelligence scores.

Table 19. ANOVA paradigm of learning attitude scores.

ANOVA[a]					
Sum of model squares		Df	Mean square	F	Sig.
1(b) Regression	5422.676	5	1084.535	34.346	0.000
Residual	15598.802	494	31.577	—	—
Total	21021.478	499	—	—	—
2(c) Regression	5449.000	6	908.167	28.751	0.000
Residual	15572.478	493	31.587	—	—
Total	21021.478	499	—	—	—
3(d) Regression	5478.413	7	782.630	24.773	0.000
Residual	15543.065	492	31.592	—	—
Total	21021.478	499	—	—	—

Note: a. Dependent variable: Post attitude.
b. Predictors: (Constant), college E, gender, college M, college B and college W.
c. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
d. Predictors: (Constant), college E, gender, college M, college B and college W cognitive, gender*cognitive.

Table 20. Hierarchical regression results of learning attitude scores.

Model summary									
Mode R		R square	Adjusted R square	Std. error of the estimate	R square change	F change	df1	df2	Sig. F change
a	0.508	0.258	0.250	5.619	0.258	34.346	5	494	0.000
b	0.509	0.259	0.250	5.620	001	0.833	1	493	0.362
c	0.511	0.261	0.250	5.621	0.001	0.931	1	492	0.335

Note: a. Predictors: (Constant), college E, gender, college M, college B and college W.
b. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
c. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive, gender*cognitive.

Table 21. Coefficients of learning attitude scores

Coefficients[a]					
Unstandardized model B		d coefficients std. error	Standardized coefficients beta	t	Sig.
(Constant)	69.697	0.627	—	111.246	0.000
Gender	-2.539	0.504	-0.196	-5.041	0.000
College M	-2.581	0.795	-0.159	-3.247	0.001
College W	-3.406	0.795	-0.210	-4.285	0.000
College B	4.375	0.795	0.270	5.505	0.000
College E	3.023	0.795	0.186	3.802	0.000
(Constant)	69.996	0.707	—	99.003	0.000
Gender	-2.530	0.504	-0.195	-5.020	0.000
College M	-2.581	0.795	-0.159	-3.246	0.001
College W	-3.453	0.797	-0.213	-4.335	0.000
College B	4.394	0.795	0.271	5.526	0.000
College E	3.009	0.795	0.186	3.783	0.000
Cognitive	-.476	0.521	-0.036	-0.913	0.362
(Constant)	70.314	0.780	—	90.099	0.000
Gender	-3.153	819	-0.243	-3.848	0.000
College M	-2.573	0.795	-0.159	-3.237	0.001
College W	-3.475	0.797	-0.214	-4.360	0.000
College B	4.419	0.796	0.273	5.554	0.000
College E	3.012	0.795	0.186	3.787	0.000
Cognitive	-1.002	0.755	-0.075	-1.328	0.185
Gender*cognitive	1.004	1.040	0.073	0.965	0.335

Note: a. Dependent variable: Post attitude.

The analyses of Tables 19, 20 and 21 indicate that after considering gender and school, cognitive style and the interaction term between cognitive style and gender are not significantly related to students' learning attitude scores.

4.2.2. Flipped Classroom Model

A similar hierarchical regression analysis was conducted to investigate whether cognitive style moderates the relationship between the selected demographic profiles (college and gender) and learning performance in flipped classroom model. The hierarchical regression models were specified as follows:

$$Model\ 1: Learning\ Performance = \beta 0 + \beta 1(College) + \beta 2(Gender) + \varepsilon$$

$$Model\ 2: Learning\ Performance = \beta 0 + \beta 1(College) + \beta 2(Gender) + \beta 3(Cognitive\ Style) + \varepsilon$$

$$Model\ 3: Learning\ Performance = \beta 0 + \beta 1(College) + \beta 2(Gender) + \beta 3(Cognitive\ Style) + \beta 5(CollegeCognitive\ Style) + \beta 6(GenderCognitive\ Style) + \varepsilon$$

Table 22. ANOVA paradigm of academic achievement test scores.

ANOVA[a]					
Sum of model squares		**df**	**Mean square**	**F**	**Sig.**
1(b) Regression	4583.127	5	916.625	42.915	0.000
Residual	10551.295	494	21.359	—	—
Total	15134.422	499	—	—	—
2(c) Regression	4597.034	6	766.172	35.846	0.000
Residual	10537.388	493	21.374	—	—
Total	15134.422	499	—	—	—
3(d) Regression	4625.035	7	660.719	30.932	0.000
Residual	10509.387	492	21.361	—	—
Total	15134.422	499	—	—	—

Note: a. Dependent variable: Post academic test.
b. Predictors: (Constant), college E, gender, college M, college B and college W.
c. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
d. Predictors: (Constant), college E, gender, college M, college B, college W cognitive and gender*cognitive.

Table 23. Hierarchical regression results of academic achievement test scores.

Model summary									
Mode	**R**	**R square**	**Adjusted R square**	**Std. error of the estimate**	**Change statistics**				
					R square change	**F change**	**df1**	**df2**	**Sig. F change**
a	0.550	0.303	0.296	4.622	0.303	42.915	5	494	0.000
b	0.551	0.304	0.295	4.623	0.001	.651	1	493	0.420
c	0.553	0.306	0.296	4.622	0.002	1.311	1	492	0.253

Note: a. Predictors: (Constant), college E, gender, college M, college B and college W.
b. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
c. Predictors: (Constant), college E, gender, college M, college B, college W, cognitive and gender*cognitive.

Table 24. Coefficients of academic achievement test scores.

Coefficients[a]					
Unstandardized model B		**Coefficients std. error**	**Standardized coefficients beta**	**t**	**Sig.**
(Constant)	70.591	0.515	—	136.999	0.000
Gender	3.052	0.414	0.277	7.367	0.000
College M	3.321	0.654	0.241	5.081	0.000
College W	-2.958	0.654	-0.215	-4.526	0.000
College B	3.081	0.654	0.224	4.713	0.000
College E	-2.127	0.654	-0.155	-3.253	0.001
(Constant)	70.801	0.577	—	122.647	0.000
Gender	3.053	0.414	0.277	7.366	0.000
College M	3.318	0.654	0.241	5.074	0.000
College W	-2.986	0.655	-0.217	-4.559	0.000
College B	3.060	0.654	0.222	4.677	0.000
College E	-2.141	0.654	-0.156	-3.272	0.001
Cognitive	-0.339	0.420	-0.030	-0.807	0.420
(Constant)	70.542	0.620	—	113.800	0.000
Gender	3.618	0.645	0.328	5.611	0.000
College M	3.266	0.655	0.237	4.985	0.000
College W	-2.996	0.655	-0.218	-4.576	0.000
College B	2.961	0.660	0.215	4.486	0.000
College E	-2.170	0.655	-0.158	-3.315	0.001
Cognitive	0.173	0.613	0.015	0.282	0.778
Gender*cognitive	-0.972	0.849	-0.082	-1.145	0.253

Note: a. Dependent variable: Post academic test.

Tables 22, 23, and 24 show that all three models are statistically significant. The results indicate that cognitive style and the interaction term between cognitive style and gender are not significantly related to students' academic achievement test scores after considering gender and school.

Table 25. ANOVA paradigm of successful intelligence scores.

ANOVA[a]					
Sum of model squares		**df**	**Mean square**	**F**	**Sig.**
1(b) Regression	848.762	5	169.752	52.440	0.000
Residual	1599.110	494	3.237	—	—
Total	2447.872	499	—	—	—
2(c) Regression	848.836	6	141.473	43.618	0.000
Residual	1599.036	493	3.243	—	—
Total	2447.872	499	—	—	—
3(d) Regression	849.442	7	121.349	37.351	0.000
Residual	1598.430	492	3.249	—	—
Total	2447.872	499	—	—	—

Note: a. Dependent variable: Post intelligence.
b. Predictors: (Constant), college E, gender, college M, college B and college W.
c. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
d. Predictors: (Constant), college E, gender, college M, college B, college W cognitive and gender*cognitive.

Table 26. Hierarchical regression results of successful intelligence scores.

Model summary									
Model	**R**	**R square**	**Adjusted R square**	**Std. error of the estimate**	**Change statistics**				
					R square change	**F change**	**df1**	**df2**	**Sig. F change**
a	0.589	0.347	0.340	1.799	0.347	52.440	5	0.494	0.000
b	0.589	0.347	0.339	1.801	0.000	0.023	1	0.493	0.880
c	0.589	0.347	0.338	1.802	0.000	0.187	1	0.492	0.666

Note: a. Predictors: (Constant), college E, gender, college M, college B and college W.
b. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
c. Predictors: (Constant), college E, gender, college M, college B, college W, cognitive and gender*cognitive.

Table 27. Coefficients of successful intelligence scores.

Coefficients[a]					
Unstandardized		**d coefficients**	**Standardized coefficients**	**t**	**Sig.**
Model	**B**	**Std. error**	**Beta**		
(Constant)	28.012	0.201	—	139.646	0.000
Gender	1.269	0.161	0.286	7.867	0.000
College M	-0.705	0.254	-0.127	-2.769	0.006
College W	-0.952	0.254	-0.172	-3.741	0.000
College B	2.093	0.254	0.378	8.224	0.000
College E	1.073	0.255	0.194	4.217	0.000
(Constant)	28.027	0.225	—	124.635	0.000
Gender	1.269	0.161	0.286	7.860	0.000
College M	-0.705	0.255	-127	-2.767	0.006
College w	-0.954	0.255	-0.172	-3.740	0.000
College B	2.091	0.255	0.378	8.204	0.000
College E	1.072	0.255	0.194	4.207	0.000
Cognitive	-0.025	0.164	-0.006	-0.151	0.880
(Constant)	28.066	0.242	—	116.095	0.000
Gender	1.186	0.251	0.267	4.714	0.000

Coefficients[a]					
Unstandardized		d coefficients	Standardized coefficients	t	Sig.
Model	B	Std. error	Beta		
College M	-0.697	0.256	-0.126	-2.729	0.007
College W	-0.952	0.255	-0.172	-3.730	0.000
College B	2.106	0.257	0.381	8.183	0.000
College E	1.077	0.255	0.195	4.217	0.000
Cognitive	-0.100	0.239	-0.022	-0.418	0.676
Gender*cognitive	0.143	0.331	0.030	0.432	0.666

Note: a. Dependent variable: Post intelligence.

Tables 25, 26 and 27 indicate that cognitive style and the interaction term between cognitive style and gender are not significantly related to students' successful intelligence scores after considering gender and school.

Table 28. ANOVA paradigm of learning attitude scores.

ANOVA[a]					
Sum of model squares		df	Mean square	F	Sig.
1 (b) Regression	6767.706	5	1353.541	40.086	0.000
Residual	16680.572	494	33.766	—	—
Total	23448.278	499	—	—	—
2 (c) Regression	6770.703	6	1128.450	33.358	0.000
Residual	16677.575	493	33.829	—	—
Total	23448.278	499	—	—	—
3 (d) Regression	6770.906	7	967.272	28.536	0.000
Residual	16677.372	492	33.897	—	—
Total	23448.278	499	—	—	—

Note: a. Dependent variable: Post attitude.
b. Predictors: (Constant), college E, gender, college M, college B and college W.
c. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
d. Predictors: (Constant), college E, gender, college M, college B, college W cognitive and gender*cognitive.

Table 29. Hierarchical regression of learning attitude scores.

Model summary									
Mode	R	R square	Adjusted R square	Std. error of the estimate	R square change	F change	df1	df2	Sig. F change
A	0.537	0.289	0.281	5.811	0.289	40.086	5	494	0.000
B	0.537	0.289	0.280	5.816	0.000	0.089	1	493	0.766
c	0.537	0.289	0.279	5.822	0.000	0.006	1	492	0.938

Note: a. Predictors: (Constant), college E, gender, college M, college B and college W.
b. Predictors: (Constant), college E, gender, college M, college B, college W and cognitive.
c. Predictors: (Constant), college E, gender, college M, college B, college W, cognitive and gender*cognitive.

Table 30. Coefficients of learning attitude scores.

Coefficients[a]					
Unstandardized		Std. error	Standardized coefficients	t	Sig.
Model	B		Beta		
(Constant)	98.822	0.648	—	152.535	0.000
Gender	4.414	0.521	0.322	8.474	0.000
College M	-2.282	0.822	-0.133	-2.776	0.006
College W	-1.888	0.822	-0.110	-2.297	0.022
College B	5.244	0.822	0.306	6.381	0.000
College E	3.351	0.822	0.196	4.075	0.000
(Constant)	98.725	0.726	—	135.940	0.000
Gender	4.414	0.521	0.322	8.466	0.000

Coefficients[a]					
Unstandardized			Standardized coefficients	t	Sig.
Model	B	Std. error	Beta		
College M	-2.280	0.823	-0.133	-2.772	0.006
College W	-1.875	0.824	-0.110	-2.276	0.023
College B	5.254	0.823	0.307	6.382	0.000
College E	3.357	0.823	0.196	4.078	0.000
Cognitive	0.157	0.528	0.011	0.298	0.766
(Constant)	98.747	0.781	—	126.458	0.000
Gender	4.365	0.812	0.318	5.374	0.000
College M	-2.276	0.825	-0.133	-2.757	0.006
College W	-1.874	0.825	-0.109	-2.273	0.023
College B	5.262	0.831	0.307	6.330	0.000
College E	3.359	0.825	0.196	4.074	0.000
Cognitive	0.114	0.772	0.008	0.147	0.883
Gender*cognitive	0.083	1.069	0.006	0.077	0.938

Note: a. Dependent variable: Post attitude.

Tables 28, 29 and 30 indicate that cognitive style and the interaction term between cognitive style and gender are not significantly related to students' learning attitude scores after considering gender and school.

4.3. Discussion

This section synthesizes the results of the analyses from the previous sections discussing the above findings regarding the hypotheses tested, the impact of flipped classrooms in the "management" course at VTCs, and cognitive style's moderation on the effectiveness of flipped classrooms.

4.3.1. Verification Results of Research Hypotheses

After conducting the educational experiment, out of the six hypotheses proposed, three were supported by the findings while the other three did not receive supporting evidence. The results are shown in Table 31.

Table 31. Research hypothesis verification results.

Hypotheses	Hypotheses content	Verification result
Hypothesis 1	There is a difference in achievement test performance before and after teaching duration between students who receive "flipped classroom" teaching and those who receive "traditional teaching".	Supported
Hypothesis 2	There is a difference in the performance of successful intelligence (Analytical, creative, and practical intelligence) before and after teaching duration between students who receive "flipped classroom" teaching and those who receive "traditional teaching".	Supported
Hypothesis 3	There is a difference in learning attitudes before and after teaching duration between students who receive "flipped classroom" teaching and those who receive "traditional teaching".	Supported
Hypothesis 4	There is a difference in achievement test performance after teaching duration among students with different cognitive styles who receive "flipped classroom" teaching.	Not supported
Hypothesis 5	There is a difference in the performance of successful intelligence (Analytical, creative, and practical intelligence) after teaching duration among students with different cognitive styles who receive "flipped classroom".	Not supported
Hypothesis 6	There is a difference in learning attitudes after teaching duration among students with different cognitive styles who receive a "flipped classroom".	Not supported

4.3.2. Flipped Classroom Facilitates Students' Performance in the "Management" Curriculum Area

4.3.2.1. Better Performance in Subject-Specific Achievement Tests in the Flipped Classroom

The experimental group demonstrated greater improvements in learning achievement. This affirms the flipped classroom's efficacy over conventional educational strategies. McAuley, Leskovec, and Jurafsky (2012) observed enhanced learning effectiveness and cognitive performance in pharmacology courses through flipped classrooms. Similarly, Wang and Zhang (2020) noted improved student grades and engagement in an educational English course at the university level with this approach. Talley and Scherer (2013) also reported improved learning performance in university STEM courses through flipped classrooms. Collectively, these studies underscore the flipped classroom's potential to boost students' learning effectiveness, engagement, proactive learning behaviors, and teacher-student interaction.

4.3.2.2. Flipped Classroom Leads to Better Performance in Successful Intelligence

According to the study, both the experimental and control groups showed improvements in successful intelligence (analytical, creative, and practical intelligence) after testing, with average scores higher than those before testing. The experimental group's average improvement was significantly better demonstrating that the flipped classroom serves better in improving successful intelligence.

4.3.2.3. Flipped Classroom Improves Students' Attitudes toward Learning in Their Specialized Courses

The analysis showed that both experimental (flipped classroom) and control (traditional teaching) groups improved in learning attitudes with the experimental group exhibiting significantly greater improvement. This underscores the flipped classroom's superiority in boosting students' learning attitudes over traditional methods. Supporting research, including Zappe, Leicht, Messner, Litzinger, and Lee (2009) on architectural engineering, Ruddick (2012) on chemistry and Strayer (2012) on introductory statistics similarly found that the flipped classroom enhances students' learning attitudes suggesting it to more engaging than traditional teaching. The ability of flipped classrooms to improve educational experiences is demonstrated by enhanced attentiveness, stronger cognitive learning, improved teacher-student interaction, and more proactive learning attitudes that students expressed.

4.3.3. Cognitive Style Has No Moderating Effect in Specialized Courses

The analysis revealed that cognitive style does not significantly influence learning performance (learning achievement tests, successful intelligence, and learning attitudes) in the context of flipped classrooms versus traditional teaching indicating that cognitive style does not moderate the effectiveness of teaching methods. Students with a visual cognitive style consistently outperformed those with a verbal cognitive style regardless of the teaching approach. These results contrast with Chang, Lin, and Chen (2019) who identified differences in learning effectiveness and cognitive load based on cognitive style, particularly favoring visually oriented students in "graphics + text" and "video + text" formats. However, the current study aligns more closely with Alalouch's (2021) findings suggesting that cognitive style doesn't significantly affect learning performance with visually oriented students generally faring better. The absence of a moderating effect by cognitive style here may be due to the internet generation's familiarity with digital media and online technologies for learning, which supports the superior performance of visually oriented students across both flipped classroom and traditional teaching methods, possibly because even traditional methods often incorporate visual aids that benefit these learners.

5. CONCLUSION

This study focused on integrating flipped classrooms into vocational and technical college curricula as a teaching and learning strategy. This teaching approach has been shown to enhance student's learning performance and application in management courses through empirical research. According to the analysis of quantitative data from

this study, students in both groups made significant progress in cognitive learning achievements in management courses. However, students in the flipped classroom setting showed greater improvement indicating that a flipped classroom is more effective in enhancing cognitive learning in management compared to traditional teaching methods. This study verifies that a flipped classroom effectively enhances students' successful intelligence. This approach not only benefited their understanding of the course content but also positively impacted their interpersonal relationships with classmates. This study found that in the process of learning management courses, students under the flipped classroom approach exhibited a more positive attitude towards learning, showing a greater improvement compared to those receiving traditional instruction. This indicates that students have a favorable attitude towards learning activities conducted under the flipped classroom model. This model actively engages students in learning. It encourages discussions and problem-solving with peers, improving their sense of achievement in learning, and fostering greater confidence and a more positive attitude towards their studies. Lastly, this study found that the learning performance of students following flipped classrooms and traditional teaching methods did not significantly differ based on cognitive style. Students with a visual cognitive style consistently outperformed those with a verbal cognitive style regardless of the teaching approach. In other words, students in this study with a visual cognitive style performed better than those with a verbal cognitive style despite whether the flipped classroom uses a lot of multimedia or traditional teaching methods that depends on lectures.

6. RECOMMENDATIONS

6.1. Recommendations for Flipped Classroom Practice

It is crucial to make use of professional community support in the preparation of online materials thus minimizing teacher workload in the process of using a flipped classroom. When preparing videos, teachers should consider possible problems such as device compatibility and reliability of internet connections. Showing how to use video equipment and inculcating the habits of pausing and replaying videos are also important for student self-study. The ability of the students to be able to access technology is very important for proper implementation. At classroom activities, teachers should acquaint students with the course calendar and learning practices, create a common learning environment, render timely assistance, and tailor it to introverted students. For evaluations, specific instructional objectives should be determined and assessments need to reflect only higher cognitive skills rather than memorization. Prior-class evaluations are important in diagnosing learning deficits and fostering critical thinking.

6.2. Recommendations for College Administration

Teachers' teaching skills and knowledge capacity should be developed to promote a successful transition into a flipped classroom environment. This may include obtaining support for learning enhancement, introducing guests for lectures, and fostering feelings of partnership among the teachers. Furthermore, colleges should encourage teachers in their transition to the more active and demanding type of flipped classrooms along with admiration for their efforts, and provision of better equipment and facilities. Assisting teachers in organizing college-based professional learning communities can relieve them from the individual burden of lesson preparation, thus enabling better teaching. Further studies should investigate the level of application of flipped classrooms in distinct subjects taught at VTCs and evaluate their effectiveness on measures such as cognitive load, technology acceptance, cooperative learning, and problem-solving skills.

The use of AI in flipped classrooms contributes significantly to the functioning of this teaching approach rather than just enhancing effectiveness. It can also be used in the forming of individualized study materials and the adjustment of the complexity of the content according to the individual student's results and the speed of their studying. This individualized methodology is designed to ensure that every student gets content that is the most suitable and effective for his or her level of grasp which eventually boosts the engagement and the retention level. Similarly, AI can help replicate the automation of parity tasks like grading as well as feedback on pre-class homework

so that teachers have more time and resources to devote to interactive and student-centered activities during class time. AI-improved data analytics can as well provide tutors with real-time analytics of student behavior and engagement, hence precise and immediate interventions. AIs should be purchased and trained to maximize their efficacy through teachers, and schools and colleges should consider investments in these tools. These approaches will not only take teacher workload down but also establish an environment for learning that will be more flexible and suitable for the daily learning needs of vocational and technical students.

In a nutshell, this study presents the flipped classroom as a holistic strategy that incorporates technology, teamwork and active learning to better prepare students for success in the workplace rather than merely as a pedagogical choice. Education authorities can improve the quality of VTE, preparing students for the contemporary labour market by adopting these recommendations. This teaching model will not only elevate students' learning experience but also foster a skilled, adaptable, and innovative workforce.

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Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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APPENDIX

APPENDIX includes the following components: Appendix A presents the Management Academic Achievement Test, consisting of multiple-choice questions where no points are awarded for partial, omitted, or incomplete selections, with a total of 20 questions worth five points each, for a maximum score of 100 points. Appendix B features the Successful Intelligence Scale, designed to assess individual learning processes related to successful intelligence, with responses kept confidential for educational research purposes. Appendix C contains the Learning Attitude Scale, which evaluates attitudes toward learning, scored from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating more favorable attitudes. Appendix D presents the Cognitive Style SOP (Style of Processing) Scale, exploring personal processing styles, also used solely for educational research, ensuring confidentiality. Participants are encouraged to respond honestly based on their experiences.

Appendix A. Management academic achievement test

The following are multiple-choice questions. No points will be awarded for partial, omitted, or incomplete selections. Each question is worth five points, with a total of 20 questions and a maximum score of 100 points.

1. Which of the following statements about the authoritative management style are correct? ( )

A) Authoritative managers usually make all decisions themselves.

B) This style is suitable for emergency situations requiring quick decisions.

C) Authoritative managers tend to build close personal relationships with employees.

D) Authoritative management style may inhibit employees' creativity.

Answer: A, B, D

2. Which of the following are advantages of the relational management style? ( )

A) Promotes team cohesion and employee satisfaction.

B) Improves communication efficiency within the organization.

C) Facilitates quick decision-making and execution.

D) Enhances employee loyalty and sense of belonging.

Answer: A, B, D

3. Which of the following statements about transactional leadership style are correct? ( )

A) Transactional leaders primarily focus on task completion and performance.

B) This style is suitable for stable and structured environments.

C) Transactional leaders often motivate employees through rewards and punishments.

D) Transactional leadership style typically encourages employees to propose innovative ideas.

Answer: A, B, C

4. What challenges may arise with a participative management style? ( )

A) The decision-making process may become slow.

B) Managers may lose control over the team.

C) It may increase competition among employees.

D) More time and resources may be needed for coordination and communication.

Answer: A, B, D

5. According to Hersey and Blanchard's situational leadership theory, how should leadership styles be adjusted based on employees' maturity levels? ( )

A) For low-maturity employees, leaders should use a high-task, low-relationship directing style.

B) For moderately mature employees, leaders should use a high-task, high-relationship coaching style.

C) For high-maturity employees, leaders should use a low-task, high-relationship supporting style.

D) For fully mature employees, leaders should use a low-task, low-relationship delegating style.

Answer: A, B, C, D

6. Which of the following are core characteristics of transformational leaders? ( )

A) Having vision and foresight

B) Emphasizing personal development of team members

C) Relying on formal authority and positional power

D) Inspiring employees' innovation and creativity

Answer: A, B, D

7. In which situations is a transactional leadership style suitable when applying leadership theories to practical cases? ( )

A) When ensuring timely completion of short-term goals and tasks

B) When the organization is undergoing major changes and uncertainties

C) When workflows are highly standardized and need strict adherence

D) When quick decision-making is required in emergencies

Answer: A, C, D

8. Which of the following statements about team building are correct? ( )

A) Team building helps improve communication among team members.

B) Team building activities can increase mutual trust and collaboration.

C) Team building is only beneficial for newly formed teams.

D) Effective team building can lead to higher overall team performance.

Answer: A, B, D

9. What aspects should be focused on when using SWOT analysis for decision-making? ( )

A) Internal strengths

B) External opportunities

C) Internal weaknesses

D) External threats

Answer: A, B, C, D

10. Which of the following statements about decision tree models are correct? ( )

A) Decision trees help identify potential outcomes of different decision paths.

B) Decision trees are suitable for analyzing complex decision problems.

C) Decision trees are mainly used to identify and analyze market trends.

D) Decision trees can quantify risks and rewards of different options.

Answer: A, B, D

11. What principles should be followed when applying brainstorming techniques to the decision-making process? ( )

A) Encourage all participants to express ideas freely.

B) Criticism and evaluation should be conducted during the idea generation stage.

C) Generate as many ideas as possible.

D) Combine and improve existing ideas.

Answer: A, C, D

12. What are the key steps in structured problem-solving strategies? ( )

A) Problem definition

B) Data collection and analysis

C) Intuitive decision-making

D) Implementation and evaluation

Answer: A, B, D

13. Which of the following statements about the PDCA cycle (Plan-Do-Check-Act) are correct? ( )

A) The planning phase includes setting goals and developing strategies.

B) The execution phase involves the actual implementation of the plan.

C) The checking phase includes evaluating results and identifying problems.

D) The acting phase includes standardizing successful strategies and improving plans.

Answer: A, B, C, D

14. Which of the following statements about the 5 Whys method are correct? ( )

A) It involves continuously asking "why" to dig deep into the root cause of a problem.

B) It is suitable for root cause analysis of both simple and complex problems.

C) Precisely five "why" questions are typically needed.

D) It helps identify systemic and recurring issues.

Answer: A, D

15. Which of the following statements about modern recruitment processes are correct? ( )

A) Recruitment processes typically include job analysis, posting job openings, and screening resumes.

B) The recruitment process should emphasize building the employer brand.

C) The purpose of recruitment is to fill vacancies as quickly as possible.

D) Recruitment processes should follow principles of fairness and non-discrimination.

Answer: A, B, D

16. What factors should be considered when evaluating the effectiveness of different recruitment strategies? ( )

A) Recruitment costs

B) Performance and adaptability of new hires

C) Coverage of recruitment channels

D) Duration of the recruitment process

Answer: A, B, D

17. Which of the following statements about behavioral interview techniques are correct? ( )

A) Behavioral interviews focus on specific behaviors in the candidate's past work.

B) Behavioral interview questions typically begin with "Please give an example of..."

C) Behavioral interviews can predict a candidate's future job performance.

D) Behavioral interviews mainly assess the candidate's technical skills.

Answer: A, B, C

18. Which motivational strategies can help promote employees' innovation capabilities? ( )

A) Offering creative bonuses and rewards

B) Establishing innovation labs and creative spaces

C) Implementing strict performance evaluation systems

D) Encouraging cross-departmental collaboration and teamwork

Answer: A, B, D

19. What key performance indicators (KPIs) should be considered when evaluating the outcomes of innovation management programs? ( )

A) The number of new products or services

B) The success rate of innovation projects

C) Employee job satisfaction

D) Growth in company profits and market share

Answer: A, B, D

20. Which of the following measures can effectively support and maintain an internal culture of innovation within a company? ( )

A) Providing ongoing training and development opportunities for employees

B) Setting up dedicated innovation teams or departments

C) Emphasizing results rather than processes in evaluation criteria

D) Regularly organizing creativity and innovation competitions

Answer: A, B, D

Appendix B. Successful intelligence scale.

This scale is designed to understand the extent of your individual learning process in terms of successful intelligence. The content you fill out will only be used for educational research purposes. This is not an exam; there are no standard answers, nor will it affect your academic grades, and the information you provide will not be disclosed. You only need to answer honestly based on your personal situation. Thank you for your cooperation, and I wish you academic progress!

Triarchic Intelligence Scale English Revised Version

School: Class: Name: Gender: Age: Score: ( )

Guidance:

1. Firstly, thank you for your support in this study. Your thoughtful responses are highly valuable to our research.
2. This intelligence test comprises two sections: the first part consists of 36 multiple-choice questions with a time limit of 60 minutes, and the second part consists of three essay questions, each with a writing time of 15 minutes.
3. Before attempting the multiple-choice questions, the teacher will provide explanations using sample questions. If you finish the multiple-choice section before the allocated time, you may review your answers. Once the teacher announces "stop answering" and distributes the essay questions, you may begin working on the essay section.
4. When answering the multiple-choice questions, carefully read each question, and use a pencil to mark your chosen answer. Each question allows for only one answer; do not choose multiple options or omit any.
5. All questions in the test must be completed to obtain a valid intelligence score.
6. Please complete the test independently and refrain from discussing it with others.

Once again, thank you for your cooperation!

Guidance 1: carefully read the topic, please choose the most appropriate word for each problem.

Example

The____turned green, so I crossed the road.

A. Car B. Signal C. Light D Tree

Example Question Explanation: "C," "light" is the correct answer. "The light is green, so I start crossing the street." All options may be green or related to the street, but only when the light is green you can cross the street. Please approach the following four questions in the same way as the example.

1. Two stories written by Somosa about Lucianta enabled Zods to undertake the first lunar voyage 1800 years ago, which may rightfully earn him the title of the father of science fiction. One of his many stories, "True History," is about an accidental journey. A ship, originally sailing in a mysterious sea, was blown to the moon by a sudden storm. In another story, the journey is pre-planned, where the protagonist, Learomenippus, attempts a long-distance journey using the wings of a giant bird, ultimately reaching his destination by air and flight. Zods is most likely

A. Astronaut

B. Reader

C. Scientist

D. Explorer

2. Any retail store that ignores its old customers to focus on new Jids will find no increase in sales. The new revenue is not sufficient to compensate for the loss incurred due to old customers leaving because of dissatisfaction. Jids most likely are

A. Products

B. Customers

C. Advertisements

D. Investments

3. The traveler still stood, staring at the first sign of the gap. In front of him was the enormous Sandrus Mountain, its snow-covered top appearing like wool, hard to distinguish. When the sun rose, its rays on the snow looked like a rainbow. The gap is most likely

A. Dawn

B. Land

C. Winter

D. Life

4. Today's news is produced so rapidly that we often find ourselves in a state of contradictory information without taking the time to thoroughly think through the mivs. Sometimes, our misunderstandings are simply due to misinterpreting what we see and hear, but other times, the news is indeed a mix of half-truths and unclear narratives. Mivs most likely are

A. Fallacies

B. Results

C. Contradictory Statements

D. Causes

Guidance 2: Each question involves a series of numbers, and there is a pattern within these series of numbers. Discover this pattern, and calculate what the next number in the series is.

Example

12	16	20	24	?

A 30 B 28 C 26 D 22

Example Question Explanation: The pattern is adding 4 to each number to obtain the next number in the sequence. 12 plus 4 equals 16, 16 plus 4 equals 20, and 20 plus 4 equals 24. What is the next number after 24? The answer is 28.

5.

-4	-3	-1	3	11	27	?

A 62 B 39 C 43 D 59

6.

2	8	3	27	4	64	5	?

A 125 B 100 C 121 D 81

7.

256	169	100	49	16	?

A 1 B 4 C 8 D 9

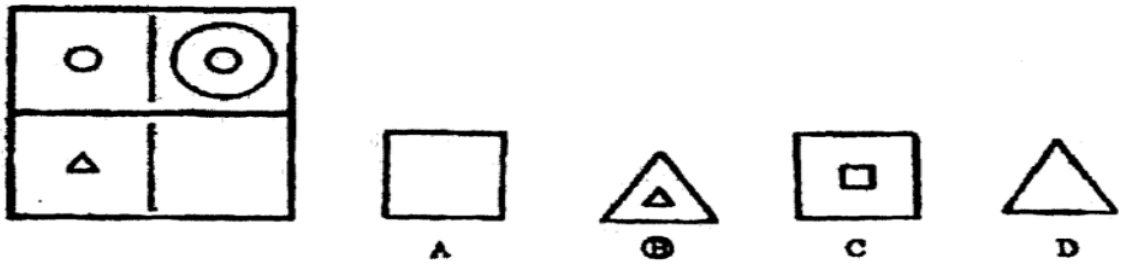
8.

3	2	12	6	48	18	?

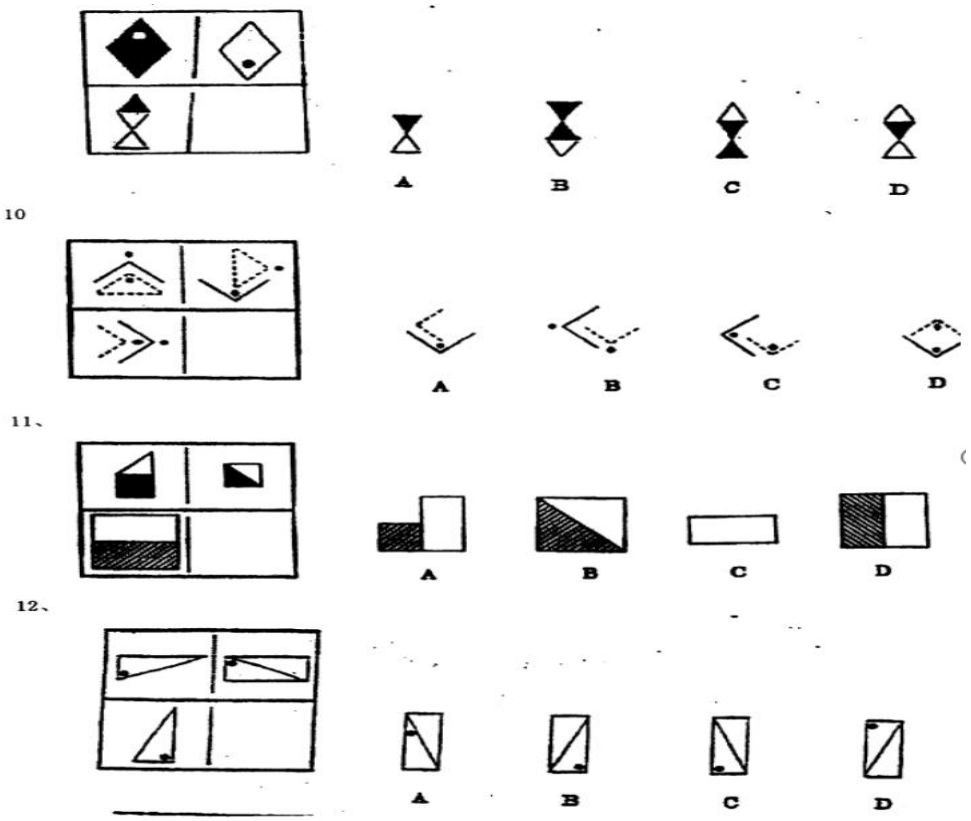
A 66 B 192 C 132 D 144

Guidance 3: In each question, the shapes in the top row of the box are arranged in a certain way, and the shapes in the bottom row of the box are arranged in the same way. Please choose the shape that fits in the empty space.

Example



Example Question Explanation: In option "B," the small triangle is positioned within the large triangle, similar to the way the small circle is positioned within the large circle.



Guidance 4: Each question represents a real-world problem that you might face. Read the question carefully and choose the best solution that fits the specific situation and desired outcome.

Example Question: A has received a college admission notice, and the annual tuition and living expenses are about 12,000 yuan. A's parents do not have a high income and can provide at most 10,000 yuan per year, and A must find a way to come up with the rest. Which of the following methods do you think is the best choice to solve this problem?

A. Apply to the university to defer enrollment for a year, work for a year to earn the required fees, and then go to college.

B. Work during the summer vacation and plan to earn the required fees through part-time jobs during college.

C. Apply for a student loan.

D. Borrow money from relatives.

Example Explanation: Answer "B" is the best choice as it enables A to earn the necessary money while also developing his/her social skills.

13. B is a senior high school student who wants to gather information about some prestigious universities, preparing to apply for a mathematics major. Which of the following methods can provide him/her with the best and quickest information resources?

A. Consult the class teacher, who might know about some university mathematics departments through materials. Also, consult the mathematics teacher, who might be aware of the strengths of different mathematics departments.

B. Consult the English teacher, who graduated from a prestigious university and has two children attending prestigious universities.

C. Visit the local university library to look up a list of universities and brief introductions of each university.

D. Ask his/her parents to inquire with their colleagues at work, as some of them might know about some university mathematics departments.

14. Your best friend has recently become addicted to the internet, often skipping classes to go to a nearby internet cafe. You want to find an effective way to help him/her and avoid disciplinary punishment as much as possible. Which of the following would be the best solution?

A. Consult with your parents, even if you are worried they might tell your friend's parents or the class teacher.

B. Ask your friend about the reasons behind their internet addiction and suggest that they seek help from the school's psychological counselor.

C. Inform the class teacher about the situation and request that they do not impose disciplinary punishment on your friend.

D. Inform your friend about the consequences of internet addiction and provide him/her with some materials on how adolescents can overcome internet addiction.

15. You have a passion for writing and aspire to be a journalist in the future. This summer, you plan to earn some money on your own to buy a newly published set of classic novels. A local newspaper is hiring part-time journalists, and you applied but were not selected. Which of the following methods do you think is best, both to earn income during the summer and to gain experience for your future career?

A. Continue to apply for part-time jobs at other newspapers, and if none are successful, you have made your best effort, and then you can ask your parents for money to buy the classic novels.

B. Unless you get a part-time job at a newspaper, do not work this summer but stay at home to practice writing.

C. Talk to the recruitment staff at the newspaper to see if they can offer you an opportunity as a volunteer reporter, while you also look for another part-time job in the evenings.

D. Inquire with the staff at the newspaper to see if there are other job positions available. Hope that once you are in the newspaper, you can prove your talent as a journalist.

16. You are planning your birthday party and want to invite some friends. Your best friend, A, tells you that if you invite B, who doesn't get along with them, they will not attend the party. Despite A's opposition, you still want to invite B. Which of the following methods is the best, showing respect to A while not offending B?

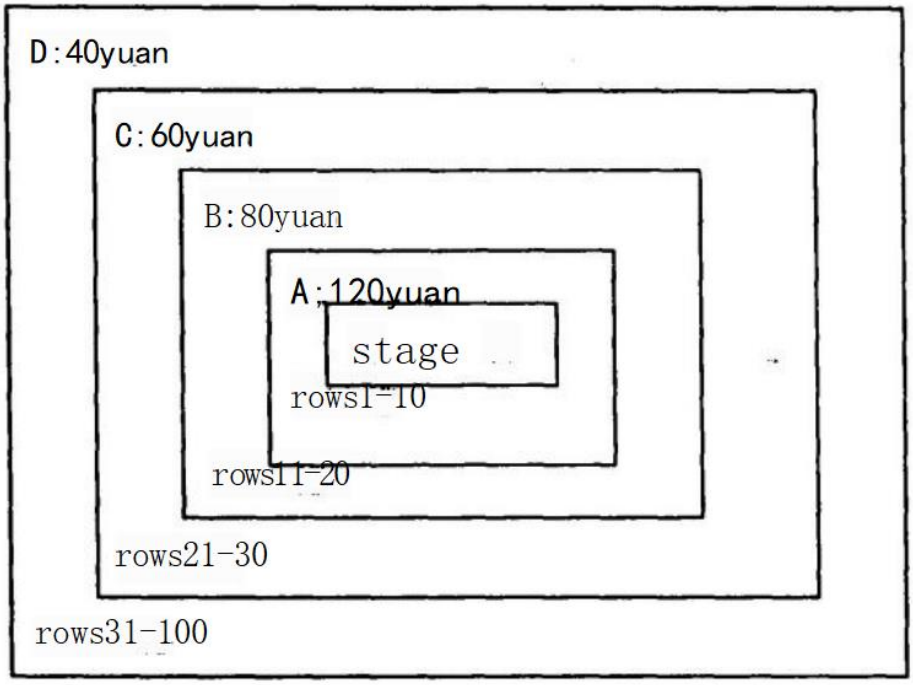
A. Do not invite B, but apologize to them, and try to explain why you need to respect A's feelings.

B. Invite B and tell A that you hope they will attend the party no matter what.

C. Invite B and then discuss your reasons with A, trying to convince them of your friendship.

D. Do not invite B and decide to organize another party this year, at which you will invite B.

Guidance 5: Each question requires you to use knowledge from everyday life. Read the question carefully and choose the best answer.



Example Question: Recently, some singers have held concerts in our city, and the ticket prices are as shown in the figure above. Zhao Ming and his cousin bought tickets for Area A, and his two classmates are sitting in the 25th row. How much did these four tickets cost in total?

A. 140 yuan B. 240 yuan C. 360 yuan D. 400 yuan

Example Explanation: Zhao Ming and his cousin's two tickets are in Area A, each ticket costing 120 yuan. His two classmates are sitting in the 25th row, with each ticket costing 60 yuan. Therefore, the total cost of the four tickets is 240 yuan plus 120 yuan, which equals 360 yuan.

Use the two cake recipes to answer question 17.	
Making Chocolate Cake	Making Fresh Milk Cake
20 grams of butter	10 grams of butter
1 cup of sugar	1 cup of sugar
2 eggs	1 eggs
2 cups of flour	1 cups of flour
8 grams of cocoa powder	1 pound of fresh milk
Produces: A 6-pound chocolate cake	Produces: A 4-pound fresh milk cake

17.Given the following ingredients: 40 grams of butter, 5 cups of sugar, 6 eggs, 7 cups of flour, 16 grams of cocoa powder, and 3 pounds of fresh milk. If you want to make 12 pounds of chocolate cake and 12 pounds of fresh milk cake, you still need to purchase:

A. 20 grams of butter and 1 egg

B. 20 grams of butter and 1 cup of flour

C. 30 grams of butter and 1 cup of sugar

D. 30 grams of butter and 1 egg

Use the table below to answer question 18:	
Gasoline prices:	
	Regular gasoline:4.4 yuan per liter Unleaded gasoline:5.2 yuan per liter Premium gasoline:6.4 yuan per liter
Self-service discount:	
	10%off per liter of gasoline

18.During the weekend, your family plans to travel by car and you stop at a gas station to refuel before leaving. The gasoline prices are as shown in the table above. Your car uses either premium gasoline or unleaded gasoline. If you have 60 yuan, how much gasoline can you buy?

A. 10 liters of premium gasoline, with service provided by the gas station.

B. 15 liters of unleaded gasoline, self-service.

C. 15 liters of regular gasoline, with service provided by the gas station.

D. 10 liters of premium gasoline, self-service.

Use the table below to answer questions 19 and 20.

Math exam scores		
Examination	**ZhangYan**	**LiMing**
1	65	86
2	84	91
3	72	88

19.If the upcoming final exams include scores for mathematics and Chinese, and Zhang Yan wants her overall grade to be average (average score 69.5-79.4), what is the lowest score she can get in Chinese?

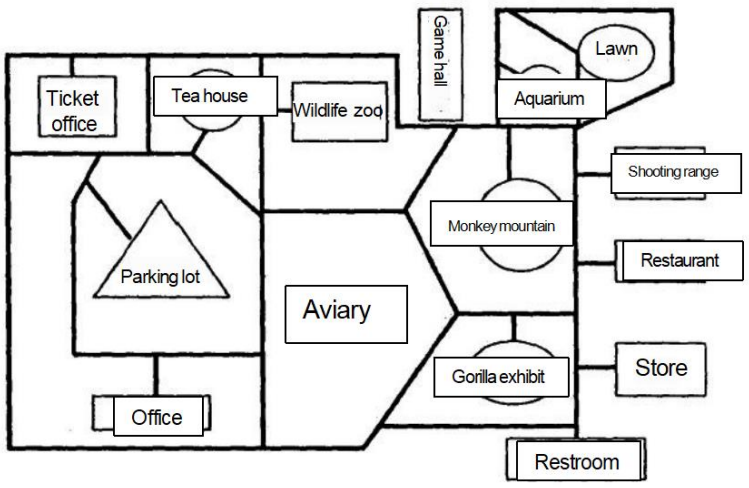
A .57 B .58 C.64 D.65

20.If the final exam scores are counted as two regular tests, and Li Ming missed the math final exam and scored 0, what is his final average score in math?

A .44 B .53 C.66 D .88

Guidance 6: The following questions require you to find the best route on a map. Read the question carefully and then choose the best answer.

Here is a map of an amusement park, where you can walk on streets with black shading. Use this map to answer the example question



Example Question: You are currently at the shop and need to go to the ticket booth to meet a friend. If you take the shortest route, you will pass:

A. The restaurant and arcade

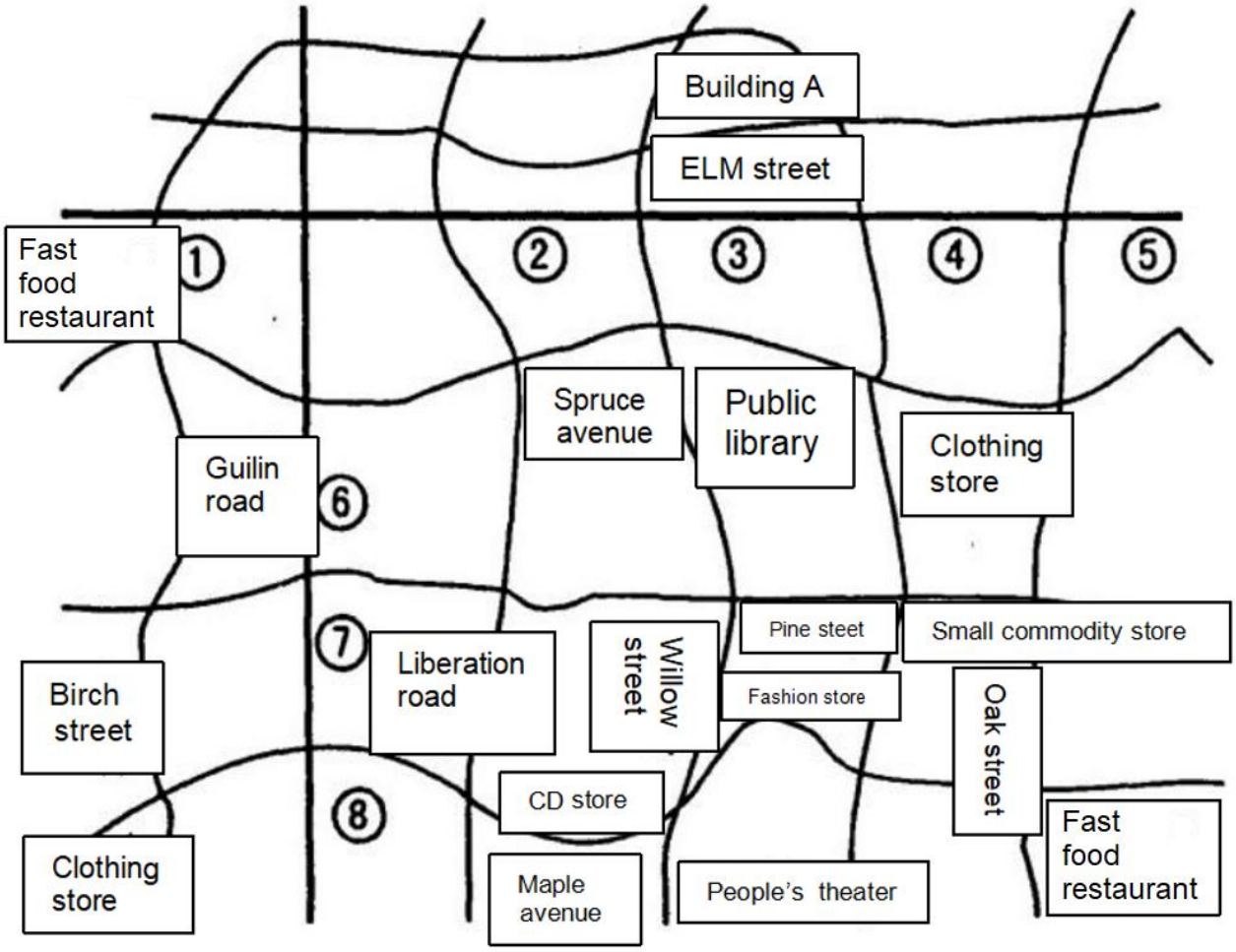
B. The gorilla pavilion and the wildlife museum

C. The gorilla pavilion and the tea house

D. The monkey mountain and the wildlife museum

Example Explanation: Choose answer B, the nearest route is from the shop, passing the gorilla pavilion and then the wildlife museum. There are several paths from the shop to the ticket booth, but the shortest route is from the shop to the gorilla pavilion, then to the wildlife museum.

The map below shows part of a large city. Use the map to answer questions 21 and 22.



21.Your school is planning to choose two locations to open bookstores. Based on the map above, which two locations do you think would attract the most customers?

A. Exits 1 and 2

B. Exits 3 and 8

C. Exits 3 and 4

D. Exits 5 and 8

22.After watching a performance at the People's Theater, you want to ride your bike home, located at point A. If you want to avoid the traffic jam at the intersection of Spruce Street and Willow Street and take the shortest route, you will ride:

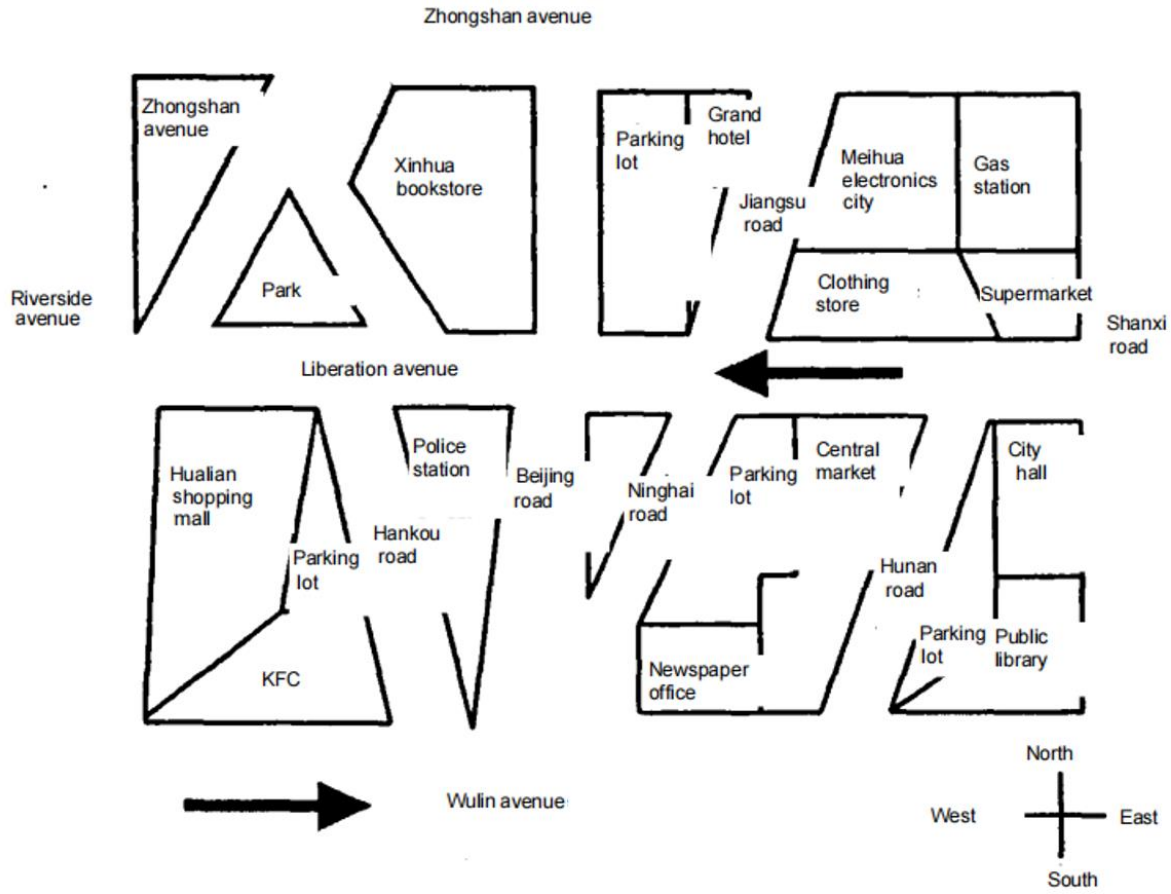
A. West of Maple Avenue, then to Guilin Road.

B. West of Pine Street, then to Jiefang Road.

C. East of Maple Avenue, then to Oak Street.

D. East of Pine Street, then to Oak Street.

Below is a map of a small town. The AN arrows indicate the direction in which cars or trucks can drive on the street. If there are no arrows, two-way traffic is allowed. Use this map to answer questions 23 and 24.



23.You are about to leave the library to meet a friend at the park. If you take the shortest route, you will:

A. West of Wuling Avenue, to Beijing Road.

B. North of Shanxi Road, to Jiefang Avenue.

C. North of Hunan Road, to Jiefang Avenue.

D. West of Wuling Avenue, to Hankou Road.

24.When you are at the gas station, a driver asks you for directions to KFC. If you choose the simplest route without violating traffic rules, you will tell him:

A. South of Shanxi Road, west of Jiefang Avenue, then south on Hankou Road.

B. South of Shanxi Road, southwest of Hunan Road, then west on Wuling Avenue.

C. West of Zhongshan Avenue, south of Yanjiang Avenue, then east on Wuling Avenue.

D. West of Zhongshan Avenue, south of Beijing Road, then west on Wuling Avenue.

Guidance 7: In each of the following questions, there is a "false" proposition that you must assume to be true. Sometimes this proposition is important in choosing the correct answer, and sometimes it is not. Also, in each question, there are three words, with the first two words combined in some way. Choose a word that matches the third word so that its combination with the third word is the same as that of the first two words.

Example: Money falls from trees.

Snow and shovel, just like dollar and:

A. Bill

B. Rake

C. Bank

D. Green

Example Explanation: The answer is B. The relationship between a rake and a dollar is similar to that between a shovel and snow, because your "false" proposition is that dollars (money) fall from trees. You use a rake to clean up money, just as you use a shovel to clean up snow.

25.Birds are singing in chorus.

Actor and monologue, just like canary and:

A. Robin

B. Soprano

C. Solo

D. Music

26.The prophet is delayed.

Historian and the past, just like prophet and:

A. Present

B. Memory

C. Future

D. Delay

27.Colors can be heard.

Taste and tongue, just like shadow and:

A. Ear

B. Light

C. Sound

D. Color

28.The ocean is crying.

Water and beach, just like ocean and:

A. Salt

B. Tears

C. Beach

D. Crying

Guidance 8: In each of the following questions, you will use special mathematical operations to solve problems. There are two special operations: "graf" and "flix".

First, see how these two operations are defined, then choose the correct answer for the problem.

A new operation called " graf" is defined as follows: If X < Y, then X graf Y = X + Y; otherwise, X graf Y = X - Y.
A new operation called " flix" is defined as follows: If A > B, then A flix B = A + B; if A < B, then A flix B = A × B; if A = B, then A flix B = A + B.

Example A:

What is 4 graf 7?

A. -3 B. 3 C. 11 D. -11

Example B:

What is 4 flix 7?

A. 28 B. 11 C. 3 D. -11

Example Explanation: The correct answer to Example A is 11, because 4 is less than 7, so here graf is the addition of two numbers. The correct answer to Example B is 28, because 4 is less than 7, so here flix is the multiplication of two numbers.

29. What is 13 graf 5?

A. 5 B. 18 C. 13 D. 8

30. What is 3 flix 7.5?

A. 10.5 B. 21.5 C. 22.5 D. 4.5

31. What is 7 graf 7?

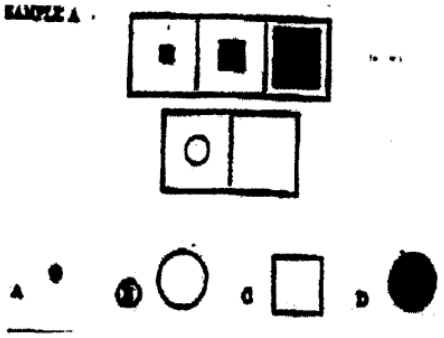
A. -7 B. 49 C. 14 D. 0

32. What is 100 flix 50?

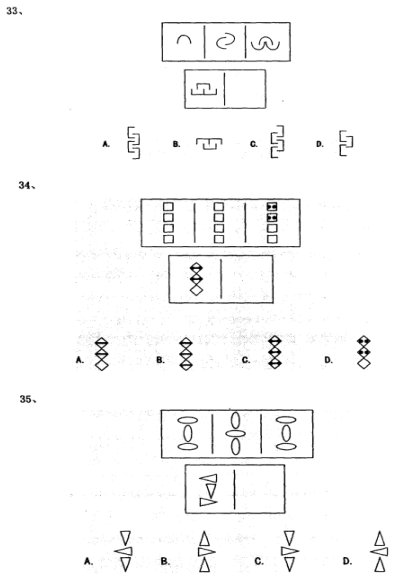
A. 2 B. 150 C. 1 D. 50

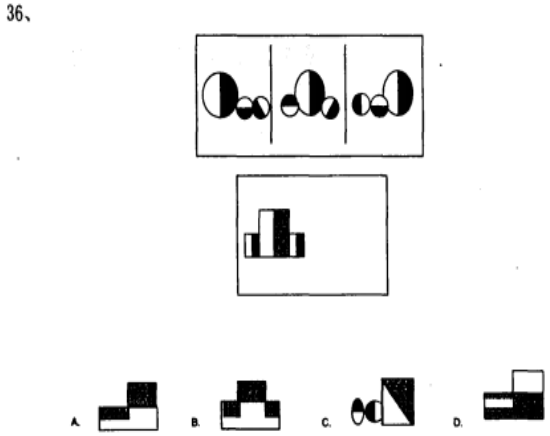
Guidance 9: In each question, the shapes in the first row of the box are arranged in a certain way, and the shapes in the second row are arranged in the same way. Please choose the shape that fits in the empty space.

Example A



Example Explanation: The larger, unshaded circle B is the correct answer. The pattern in the first row of shapes in the box is that the shaded squares progressively get larger, so following the smaller, unshaded circle in the second row, there must be a larger, unshaded circle.





Scoring Guidelines for the Triarchic Intelligence Scale

This assessment generates three fundamental scores: Analytical Intelligence (Items 1-12, Analytical essay questions), Practical Intelligence (Items 13-24, Creative essay questions), and Creative Intelligence (Items 25-36, Practical essay questions). Additionally, three supplementary scores can be obtained: Verbal Test Score (Items 1, 2, 3, 4, 13, 14, 15, 16, 25, 26, 27, 28), Quantitative Test Score (Items 5, 6, 7, 8, 17, 18, 19, 20, 29, 30, 31, 32), and Spatial Test Score (Items 9, 10, 11, 12, 21, 22, 23, 24, 33, 34, 35, 36).

Appendix C. Learning attitude scale.

This scale aims to understand your personal attitude toward the learning process. The content you fill in will only be used for educational research purposes. This is not an exam; there are no standard answers, nor will it affect your academic grades, and your information will not be disclosed. Please read each statement carefully and mark your actual feelings. A response of strongly disagree scores 1 point, disagree 2 points, somewhat agree 3 points, agree 4 points, and strongly agree 5 points. Higher scores indicate better learning attitudes.

There are no absolutely correct or incorrect answers in this questionnaire; you only need to answer honestly based on your personal situation. Thank you for your cooperation, and I wish you academic progress!

Basic Information:

Class:

Name:

Cognitive aspect	**1**	**2**	**3**	**4**	**5**
Attending classes improves my professional knowledge. 上课提高了我的专业知识。					
Attending classes enhances my professional learning experience. 上课增强了我的专业学习体验。					
Attending classes improves my ability for professional practice. 上课提高了我进行专业实践的能力。					
I think attending classes is not very difficult. 我认为上课并不是很困难。					
Attending classes helps me understand my ability in professional practice. 上课帮助我了解我在专业实践中的能力。					
Attending classes makes students like professional courses. 上课使学生喜欢专业课程。					
Attending classes allows me to learn new professional practical techniques. 上课让我学到了新的专业实践技术。					
Attending classes fosters a spirit of teamwork. 上课培养了团队合作精神。					

Affective Aspect					
I like the classroom courses. 我喜欢课堂课程。					
I hope to perform better in classroom courses. 我希望在课堂课程中表现得更好。					
I wish I could attend classroom courses every day. 我希望每天都能参加课堂课程。					
I feel a sense of achievement when mastering classroom courses. 掌握课程时，我感到一种成就感。					
Classroom courses teach me how to cooperate with others. 课堂课程教会我如何与他人合作。					
I am eager to know the content of each class. 我渴望知道每节课的内容。					
I feel happy during classroom courses. 上课时，我感到快乐。					
I look forward to each classroom course. 我期待每一次课程。					
I feel relaxed and stress-free during classroom courses. 课程中，我感到放松和无压力。					
Attending classes increases my opportunities to interact with other students. 上课增加了我与其他学生互动的机会。					
Intentional Action Aspect					
I actively collect information related to classroom courses. 我积极收集与课程相关的信息。					
I actively answer questions asked by the lecturer during class. 上课时，我积极回答讲师提出的问题。					
I use my free time to practice operations I'm not proficient in from the classroom courses. 我利用空闲时间练习课程中我不擅长的操作。					
During class, I hope the lecturer asks me to demonstrate. 上课时，我希望讲师让我示范。					
During class, I hope to become a peer tutor. 上课时，我希望成为同伴导师。					
I actively participate in activities related to the class. 我积极参与与课堂相关的活动。					
Appendix C continued					
I actively watch videos related to the class. 我积极观看与课堂相关的视频。					
I am willing to spend more time mastering professional skills from the class. 我愿意花更多时间掌握课堂中的专业技能。					
I listen attentively to the lecturer's explanations and demonstrations. 我专心听讲师的讲解和示范。					

Appendix D. Cognitive style SOP (Style of processing) scale.

This scale is designed to understand your personal style or method in handling different matters. The content you provide will only be used for educational research purposes. This is not a test, there are no right or wrong answers, and it will not affect your academic grades. Your data will remain confidential. Please read each statement carefully and mark the appropriate choice based on your actual feelings. There are no absolutely correct or incorrect answers; just answer honestly according to your personal situation. Thank you for your cooperation and best wishes for your academic progress!

Basic Information:

Class:

Name:

Statements	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I like to engage in work that requires the use of text. 我喜欢从事需要使用文字的工作。					
I like to envision future events or scenes in my mind. 我喜欢在脑海中想象未来的事件或场景。					
I seem never to find the appropriate words I need. 我似乎总是找不到需要的恰当的词语。					
I engage in many reading activities. 我经常进行阅读活动。					
I like to reminisce about special moments in my life by picturing them in my mind. 我喜欢通过在脑海中想象来回忆生活中特别的时刻。					
I think I often use words inappropriately. 我认为我经常使用不恰当的词语。					
Before engaging in an activity, I usually close my eyes and visualize how to proceed. 在进行一项活动之前，我通常会闭上眼睛想象如何进行。					
I enjoy learning new vocabulary. 我喜欢学习新词汇。					
When I hear others describe their experiences, I try to visualize the events in my mind. 当听到别人描述他们的经历时，我会尽量在脑海中想象这些事件。					
When I recall people I know, I often picture their faces in my mind. 当我想起我认识的人时，我经常在脑海中想象他们的面孔。					
Appendix D continued					
I find visualizing graphs or images in my mind helpful when doing many things. 当我在做很多事情时，我发现脑海中想象图表或图像很有帮助。					
Before attempting something, I like to read instructions on how to do it. 在尝试某件事之前，我喜欢阅读关于如何做的指示。					
I often think about synonyms for words. 我经常思考单词的同义词。					
When I have forgotten something, I often try to visualize it in my mind to remember. 当忘记某件事时，我经常试图在脑海中想象它来记住它。					
I have difficulty learning new vocabulary. 我学习新词汇有困难。					
I like to use images or pictures in my mind to help solve problems. 我喜欢在脑海中用图像或图片来帮助解决问题。					
Appendix D continued					
I prefer activities that do not require a lot of reading. 我更喜欢不需要大量阅读的活动。					
I spend very little time trying to increase my vocabulary. 我花很少时间尝试增加我的词汇量。					
I rarely visualize past events in my mind. 我很少在脑海中想象过去的事件。					
My thinking is usually composed of pictures and images. 我的思维通常由图片和图像组成。					